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ARTICLE I.

Some Additional Observations on Hydrocarbonates, and the Gaseous Oxide of Carbon. By WM. CRUICKSHANK, *Woolwich.*

IN a former paper on this subject the principal object I had in view was to point out, as briefly as possible, the difference between the common hydrocarbonates and the gaseous oxide of carbon; and to shew that the latter, hitherto unknown, forms an intermediate substance between the pure hydrocarbonates and carbonic acid, but not being possessed of acid properties, was therefore to be considered as a true oxide. I likewise endeavoured to prove that the presence of water was not essential to the production of this gas, but that it consisted simply of oxigen and carbon in the proportion of nearly two to one. From these facts I inferred that there could no longer be any difficulty in accounting, on the principles of the modern chemistry, for the inflammable gas generated in distilling a mixture of charcoal with any of the metallic oxides, or in exposing to a strong red heat a mixture of the carbonates of lime or barites, and iron filings, &c. For in the first instance the gas was formed by the union of the oxigen of the calx with the carbon, in consequence of which the metal was revived; and in the second case the carbonic acid itself was decomposed, being deprived of part of its oxigen by the metal, which thereby became to a certain degree oxidated.

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In the course of experiments from which these conclusions were drawn, a number of curious facts with regard to the different hydrocarbonates, as well as the gaseous oxide, occurred; but these not being so immediately connected with the points to be ascertained, were, for the sake of brevity, omitted; I shall now, therefore, enumerate some of the more remarkable, as well as adduce several additional proofs of the nature and composition of the gaseous oxide of carbon.

The effects of the oxigenated muriatic acid upon these, and indeed upon all inflammable gases, are worthy of attention. If the pure oxigenated muriatic acid, in the form of gas, be mixed in certain proportions with any of these inflammable gases, and introduced into a bottle filled with and inverted over water, although no immediate action may be at first perceptible, yet in twenty-four hours a complete decomposition and change of principles will be found to have taken place, the products varying according to the nature of the inflammable gas employed, as will appear from the following experiments.

I introduced into a phial (with a glass stopper) filled with and inverted over water, one measure of pure hidrogen, and afterwards two measures of very pure oxigenated muriatic acid gas;* these nearly filled the bottle; the stopper was then introduced very tight under water. Before the stopper was introduced, a whitish cloud appeared in the mixture, but very little or no diminution could be perceived. The neck of the bottle being immersed under water, was suffered to remain for twenty-four hours. At the end of this period the water had risen a little in the bottle, owing to the imperfection of the stopper; but when this was withdrawn, the whole gas instantly disappeared, except about one-tenth of a measure, which was found to be azote, and must have originally been contained in the two measures of oxigenated muriatic acid gas. In this case the products were manifestly common muriatic acid and water; for the water in the phial contained common muriatic acid, but did not in the least smell of the oxigenated. This experiment was repeated with the same results, except that the residuary gas, on the admission of water, was rather less.

This fact furnishes us with an easy method of ascertaining the purity of hidrogen gas in most cases, and even when it may be mixed with other inflammable gases, as will presently appear.

I next tried the effects of this gas upon the pure hydrocarbonates. For this purpose I introduced into a bottle, filled with and inverted over water, one measure of pure hydrocarbonate (from camphor) well washed, mixed with two measures of the oxigenated muriatic acid gas. On the first contact of the oxigenated gas, a white cloud, and some diminution, was perceived; but this soon ceased; the stopper was then introduced, and the bottle suffered to remain inverted in water for twenty-four hours. At the end of this period the stopper was withdrawn under water, when the fluid instantly rose, and the

* This gas was always obtained by adding the common muriatic acid to the oxigenated muriate of potash. It should never be kept long before it is employed, as it very soon loses part of its oxigen, and becomes decomposed.

gas

gas occupied only .43 parts of a meafure, or a diminution of 2.57 meafures had taken place. This refiduary gas being agitated with lime water, .09 parts more were abforbed, evidently carbonic acid gas. The wafhed refiduum was inflammable, and burned with a blue lambent flame, exactly fimilar to the gafeous oxides, but very different from that of the original hydrocarbonate.

This experiment was repeated with nearly the fame refults.

In this inftance, however, the gas had been recently obtained from camphor, which I have always found made a confiderable difference in the proportions of the products.* On the addition of the oxigenated muriatic acid gas to the hydrocarbonate, a diminution of no lefs than three-fourths of a meafure immediately took place, and after ftanding for twenty-four hours, the water, on withdrawing the ftopper, rofe fo high, that the remaining gas occupied the fpace of not more than .54 parts of a meafure; hence the whole diminution muft have been 2.46 meafures. This refiduary gas contained one-fifth of its bulk of carbonic acid, the remainder being inflammable. Two fmall meafures of this inflammable gas, fired with two meafures of oxigen in a jar, over mercury, were reduced to 2.5 meafures; of this 1.7 were carbonic acid, and the remaining .8 or .9 oxigen gas; for it required very nearly two meafures of nitrous gas to faturate them.

Hence we perceive that two meafures of this gas, combined with about one of oxigen, produced no lefs than 1.7 meafures of carbonic acid; a circumftance which proves it to have been the gafeous oxide of carbon.

Being determined to vary the experiments as much as poffible, to prevent any miftake or overfight; I introduced into a bottle, filled with and inverted over mercury, two meafures of hydrocarbonate from æther, and immediately after four meafures of the oxigenated muriatic acid gas. Thefe completely filled the bottle, which was ftopped to prevent the acid gas from acting upon the mercury; its neck was then plunged under mercury, and kept down by a weight placed upon it.

After ftanding for twenty-four hours, the ftopper was withdrawn under mercury, which inftantly rofe and filled two-thirds of the bottle; there was a little moifture depofited on its fides, which probably abforbed the whole of the common muriatic acid gas produced. Lime water in excefs being now added, one-third was found to be carbonic acid, and the remainder inflammable.

* It might be fuppofed that this difference arifes from the abforption of carbonic acid gas; but this is by no means the cafe, for the proportion of this gas in the hydrocarbonates from æther, or camphor, is exceedingly fmall, never exceeding one-tenth, and frequently much lefs. Befides, I found, from direct experiment, that the unwafhed hydrocarbonate required more oxigen to faturate it, than the wafhed, the reverfe of which fhould have been the cafe, had the difference depended upon carbonic acid. This variation in the refults may be thus ftated:---One meafure of unwafhed hydrocarbonate requires 1.9 of oxigen to faturate it, the products being water, and 1.4 meafures of carbonic acid. But one meafure of the wafhed gas requires only 1.65 meafures of oxigen, and produces about 1.15 meafures of carbonic acid with water.

It appears to me, therefore, that fomething like a vapour diffufed through the gas, which may be feparated by wafhing, or depofited on ftanding, muft be the caufe of this change in their properties.

Two ſmall meaſures* of this waſhed gas, fired over mercury with one of oxigen, were reduced to 1.6 meaſures; the whole of which was carbonic acid, except one-fourth of a meaſure which contained oxigen, with a little azote.

This experiment, therefore, as well as the former, after making a deduction for the azotic gas, clearly ſhews that the reſiduary inflammable gas muſt have been the gaſeous oxide of carbon.

The reſults obtained in all theſe experiments with the pure hydrocarbonates and oxigenated muriatic acid gas, are very eaſily underſtood; for it is evident that the oxigenated acid muſt give out its exceſs of oxigen to the carbon and hidrogen of the inflammable gas from a ſuperior affinity; in conſequence of which we have no leſs than four new compounds, viz. common muriatic acid, water, carbonic acid, and the gaſeous oxide of carbon. Thus, then, we ſee that the gaſeous oxide may be obtained without the aid of metals, their calces, or even the carbonic acid; and this ſimple mode of formation appears to me to demonſtrate its nature and conſtituent principles beyond all poſſibility of doubt. This will be ſtill further confirmed by the following experiment:

One meaſure of hydrocarbonate from camphor, mixed with 3.8 meaſures of oxigenated muriatic acid gas, were introduced into a bottle, which they completely filled; this was cloſely ſtopped, and inverted over mercury. After ſtanding for twenty-four hours, the ſtopper was withdrawn under the mercury, which in conſequence immediately aſcended and occupied two-thirds of the bottle. The gas acted upon the ſurface of the metal, and retained a little of its natural greeniſh yellow colour; it was not, therefore, entirely decompoſed. A little diſtilled water being introduced, a further abſorption took place, and the reſiduary gas, amounting only to .8 of a meaſure, was entirely abſorbed by lime water, except a bubble, too ſmall to examine, or even to eſtimate. Now, by comparing this with the former experiments, we perceive that when one part of the inflammable gas is mixed with only two of the oxigenated muriatic acid gas, we have both carbonic acid and gaſeous oxide formed, becauſe the exceſs of oxigen in the oxigenated acid is not ſufficient to convert the whole into carbonic acid; but when one part of the inflammable is mixed with nearly four of the oxigenated, then the whole is converted into carbonic acid and water, the exceſs of oxigen being ſufficient for this purpoſe. The proportion of oxigen in the gaſeous oxide may likewiſe be eſtimated from theſe experiments.

The effects of the oxigenated muriatic acid on the other hydrocarbonates, were very nearly ſimilar.

When firſt mixed, a ſmall diminution in moſt inſtances took place, but after ſtanding for twenty-four hours, the oxigenated acid was completely decompoſed, in conſequence of which the hydrocarbonate was converted into water and carbonic acid gas, and theſe remained only a very ſmall proportion of inflammable gas, which had all the properties of the gaſeous oxide.

* Two kinds of meaſures were employed in theſe experiments, the contents of the large one being ſix times that of the ſmall.

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Being anxious to ſee the effect of this gas on the gaſeous oxide itſelf, I mixed two meaſures of this oxigenated gas with two of the gaſeous oxides well waſhed, and introduced them as uſual into a bottle inverted over water. After ſtanding for twenty-four hours, the ſtopper was withdrawn, and the water inſtantly roſe ſo high, that the remaining gas occupied the ſpace of only 1.8 meaſures, or a diminution of 2.2 had taken place. This, when agitated with lime water, was further reduced to $\frac{4}{10}$ of a meaſure, and the reſiduary gas was ſtill ſlightly inflammable.

This experiment was repeated with only this variation, that the bottle was completely filled, and had its neck plunged under mercury: the proportions of the gaſes were two meaſures gaſeous oxide, to $2\frac{2}{3}$ meaſures oxidated muriatic acid gas. After remaining for twenty-four hours, the ſtopper was withdrawn under water, when the fluid inſtantly roſe and occupied two-thirds of the bottle. This reſiduum being agitated with lime water, the whole was abſorbed, except one-ſixth of a meaſure, which was found to be azote. Hence we perceive that any quantity of gaſeous oxide may be converted into carbonic acid by mixing it with the oxigenated muriatic acid gas, juſt as the oxide of azote or nitrous g... are converted into nitrous acid by the ſame means.

There is another gaſeous ſubſtance, or rather vapour, which is powerfully acted upon by this ſuper-oxigenated gas, viz. the vapour of æther; if we fill a bottle of the capacity of three or four pints with the pure oxigenated muriatic acid gas, taking care to expel the water as completely as poſſible, and then throw into it about a drachm or half a drachm of good æther, covering its mouth immediately with a piece of light wood or paper; in a few ſeconds white vapour will be perceived moving circularly in the bottle; this will be ſoon followed by an exploſion, accompanied with flame; at the ſame time a very conſiderable quantity of carbon will be depoſited, and the bottle will be found to contain carbonic acid gas.*

If we employ alcohol inſtead of æther, a ſimilar effect will be ſometimes produced, but more time is neceſſary, and along with the charcoal and carbonic acid there is likewiſe a little æther formed.

We ſhall next conſider the effects produced on theſe inflammable gaſes, by mixing them with the oxigenated muriatic gas, and ſetting fire to the mixture by the electric ſpark. In

* Dr. Prieſtley was the firſt who diſcovered that æther, agitated with any ſpecies of gas, greatly increaſed its volume, and in moſt caſes doubled it. He likewiſe found that although this vapour was not condenſible by the ordinary degrees of cold, yet water readily abſorbed it. Having agitated ſome oxigen gas with a little æther, I found that its bulk was exactly doubled. In this ſtate the gas does not explode, but if one part of this mixture be added to three parts of oxigen, an ignited body, or the electric ſpark, then produces a dreadful exploſion, the products of which I have found to be water, with $2\frac{1}{3}$ parts of carbonic acid gas. Hence it would appear that one part of this vapour requires about ſeven of oxigen to ſaturate it, or more correctly 6.8 the products being water, with 4.6 parts carbonic acid: According to this experiment the proportion of carbon to hidrogen in the vapour of æther, or æther itſelf, ſhould be as 5 to 1 nearly; and in alcohol, from ſimilar trials, it appeared to be as 8 or 9 to 1.

many

many of thefe trials the refults differed more from the former, where mixture alone was employed, than could *a priori* have been fuppofed, as will appear from what follows.

Three meafures of pure hidrogen were introduced into a ftrong glafs jar over mercury, and four meafures of the ox. muriatic acid gas added, the electric fpark was immediately paffed through the mixture, to prevent, as far as poffible, the abforption of the gas by the mercury; after the explofion, which was feeble, the gas occupied the fpace of .75 of a meafure: water being admitted the mercury ftill rofe higher, fo that there remained only .2 of a meafure. Finding that in this experiment the oxigenated gas was in excefs, the proportions were varied as follows:

Four meafures of pure hydrogenous gas were fired with four of the ox. muriatic gas; the refiduum amounted only to half a meafure, but this contained hidrogen. Hence by comparing thefe experiments together, it would appear that three meafures of hydrogenous require three and a half of oxigenated muriatic acid gas to faturate them; the products being water and common muriatic acid. From the fame experiments we can likewife deduce the excefs of oxigen in the oxigenated muriatic acid, or the proportion of oxigen neceffary to convert the common muriatic acid into the oxigenated; for according to the above proportions, two parts of hidrogen gas require 2.3 of the oxigenated to faturate them; now two parts of hidrogen require exactly one of oxigen (eftimating by volume) to produce the fame effect. Hence every 2.3 parts of the ox. muriatic acid contain one part of oxigen, or about half its bulk more than the fame muriatic radical when in the form of common muriatic acid gas; this fact may be found ufeful in many chemical invef-tigations where the fuper-oxigenated acid is employed. In this way too we have a ready way of determining the purity of the hidrogen, for if thefe gafes perfectly pure, be fired together over mercury in the above proportions, the whole will difappear; but if the hidrogen fhould be contaminated with azote, or fome inflammable gas, there will then be a refiduum confifting either of azote, or carbonic acid gas, or both.

The next experiments were made with the pure hydrocarbonates. Here I found, when two parts of pure hydrocarbonate, recently procured from camphor, were fired over mercury by the electric fpark, with four of the ox. muriatic acid, that a great diminution, accompanied with a confiderable depofition of charcoal took place; the refiduary gas generally amounted to 1.2 or 1.5 meafures, and of this lime water abforbed about 1. or 1.2 meafures, the remainder being inflammable. In this inftance the hydrocarbonate did not yield above half the proportion of carbonic acid which it ought to have done, but this is fufficiently accounted for, from the copious depofition of charcoal.

When hydrocarbonate from æther was employed, the refults were very nearly the fame, and charcoal was more generally depofited. Finding that in thefe proportions the quantity of oxigen contained in the ox. muriatic gas was infufficient to faturate the carbon and hidrogen of the hydrocarbonates, I next fired one meafure of the latter with four of the former; after the explofion, the gas ftood at two meafures; a very little diftilled

water

water being added, the mercury roſe to 1.6, and lime water abſorbed the whole of the remainder, except .2 of a meaſure which was inflammable.

In another experiment, no leſs than five meaſures of the oxigenated gas were mixed with one of the hydrocarbonate, but ſtill at the end of the proceſs there remained a very ſmall proportion of inflammable gas, and the whole of the oxigenated was not decompoſed. In theſe inſtances, where we uſe but a ſmall proportion of the hydrocarbonate, the exploſion is very feeble, and there is ſeldom or never any depoſition of charcoal, in conſequence of which there is a more copious production of carbonic acid gas, as may be readily ſeen by comparing the experiments together. Indeed in the laſt one, the ſame proportion of carbonic acid was obtained, as if the gas had been exploded or ſaturated with oxigen; for one meaſure of pure hydrocarbonate requires very nearly two meaſures of oxigen to ſaturate it the products being water, and 1.3 or 1.4 meaſures carbonic acid gas. Now in the experiment with the oxigenated gas, one meaſure of the hydrocarbonate fired with five of this gas, produced juſt 1.3 meaſures carbonic acid, with water, &c. indeed ſince five meaſures of the ox. muriatic acid gas contain an exceſs of oxigen equivalent to two meaſures, or a very little more, this reſult ought to have been expected.

There was nothing very remarkable obſerved in exploding the impure hydrocarbonates with this gas; all of them yielded carbonic acid gas and water, but in none of them did I perceive any ſenſible depoſition of charcoal, except once from the gas obtained from the decompoſition of alcohol. Indeed the pure hydrocarbonates themſelves, in a great meaſure, loſe this property after having been waſhed, or kept over water for ſome time; that from æther retains it the longeſt. Several attempts were made at different times to explode mixtures of the ox. muriatic acid gas, and the gaſeous oxide of carbon, but without ſucceſs. On paſſing the ſpark a little whitiſh vapour was perceived round the metallic points, but this was not accompanied by any detonation, and even after a number of ſtrong ſparks had been taken in this way, it was found on the admiſſion of lime water, which immediately took up the oxigenated gas, that the gaſeous oxide had undergone no ſenſible diminution or change. This circumſtance was rather unexpected; it furniſhes us, however, with at leaſt one criterion for diſtinguiſhing this from other inflammable gaſes.

On comparing the above experiments with the reſults obtained from firing the hydrocarbonates with different proportions of oxigen, ſome obſervations not unworthy of attention may be made. We know that when any of the pure hydrocarbonates are fired with a ſmall proportion of oxigen, a little carbonic acid is produced, and the whole volume of gas inſtead of being diminiſhed is conſiderably increaſed; this increaſed gas contains no diſengaged oxigen, but is nevertheleſs very different from the original hydrocarbonate, requiring only bulk for bulk, about one fourth of the quantity of oxigen to ſaturate it *; no charcoal is ever diſengaged. But when we explode the ſame hydrocarbonate with about twice its bulk of the ox. muriatic acid gas, we have a great diminution, accompanied

* It does not appear to be gaſeous oxide, which I believe cannot be produced this way.

with

with the ſeparation of much charcoal, and only a ſmall proportion of carbonic acid generated; the remaining gas, which is inflammable, and in ſmall quantity, appears to be gaſeous oxide. Thus then we find, that by combining the ſame inflammable gas with equal quantities of oxigen under different circumſtances or combinations, very different effects may be produced.

On a former occaſion I remarked, that from the great facility with which the carbonic acid was decompoſed, when a mixture of clear iron filings and chalk were heated together in a retort, it would appear that this acid at a high temperature might be decompoſed, at leaſt partially, by any ſubſtance which had a conſiderable affinity for oxigen; and that this was the only method of obtaining the gaſeous oxide in a ſtate of purity. As this is a circumſtance of conſiderable importance, the following experiments are given in further confirmation of it:

About an ounce of chalk, which had been previouſly expoſed for about ten minutes to a low red heat, was mixed with an ounce of very bright zinc filings, theſe were introduced into a coated glaſs retort, and expoſed to a heat gradually increaſed. A little carbonic acid came over at firſt, but this was ſoon mixed with a large proportion of the gaſeous oxide, and by the time the contents of the retort were thoroughly red, nothing but pure inflammable gas was diſengaged, and in prodigious quantity. It would have been troubleſome, and in fact unneceſſary, to have collected the whole, but portions of it were examined at different periods of the proceſs, and found to continue perfectly pure, and without any ſenſible mixture of carbonic acid gas. Indeed, before I made this experiment, I hardly conceived it poſſible, that ſo complete a decompoſition could be obtained in ſo ſimple a way. Before the gas had intirely ceaſed to come over, the retort was removed, and its contents examined. In the neck of the retort there was found a quantity of the oxide of zinc in the form of flowers, lining its ſurface to a conſiderable extent: a little below this, and cloſe to the belly of the retort, there adhered a little metallic zinc which had ſublimed, but was very much tarniſhed; what remained in the belly conſiſted of the zinc deſtitute of all metallic luſtre, and mixed with an imperfect lime. The pieces of zinc, or rather oxide, crumbled between the fingers into a greyiſh powder, and ſeemed to have intirely loſt their tenacity. It is unneceſſary to add, that the gas obtained was found when fired with oxigen, &c. to have all the properties of the pureſt gaſeous oxide of carbon. The above experiment ſhews in the moſt ſatisfactory manner, how the oxigen abſtracted from the carbonic acid is diſpoſed of, for in the proceſſes with the iron filings this was not ſo manifeſt as might have been expected.

A mixture of very dry chalk and clean filings of tin were next expoſed to heat in a coated glaſs retort; the firſt products collected conſiſted of carbonic acid gas, and the gaſeous oxide in the proportion of 5 to 6. The ſecond or middle portion contained two thirds of its bulk of gaſeous oxide, and what came over afterwards conſiſted of one part carbonic acid, and three parts gaſeous oxide. The quantity in all amounted to ſeveral gallons. After the proceſs the tin was found partly oxidated, and partly

partly diffused through the chalk in small metallic globules. The decomposition of the acid in this experiment was very imperfect, when compared with that in the former, owing no doubt to the different affinities of the metals for oxigen.

Although there could be no doubt, that in all these processes with the carbonate of lime and the metals, the carbonic acid must have been decomposed in its nascent state, yet I conceived that it might give still an additional satisfaction to shew, that the same substance may be readily decomposed even when in the state of gas. This was accomplished in two ways.

Into a straight iron retort with a cylindrical belly, a quantity of dry and very pure sand was introduced, and above this a stratum of chalk which had been very carefully dried; more sand was then introduced, and rammed down, until it filled up no less than three inches of the cavity above the chalk, and upon this was placed a quantity of very clean iron filings, the whole occupying about two thirds of the belly. The retort was then fixed in a furnace, and made red hot as soon as possible; the first gas which came over was chiefly carbonic acid; the second portion amounting to a gallon, consisted of carbonic acid gas one part, and gaseous oxide three parts; the third portion being upwards of two gallons by measure, consisted of carbonic acid two parts, and gaseous oxide seven parts; and the last portions examined, contained a somewhat greater proportion of carbonic acid gas. The gaseous oxide was found to be of the purest kind. In this experiment the carbonic acid was not brought into contact with the iron in its nascent state, but after it had assumed its gaseous form, and passed through a quantity of sand. The iron filings too being unmixed with the chalk, shewed evident marks of oxidation, a considerable portion of them being converted into the state of grey oxide.

The other method by which I decomposed this acid in its gaseous form, was by making it pass through a red hot iron tube filled with iron wires. In this experiment, a bladder mounted with a stop cock, and containing a quantity of carbonic acid gas, was attached to one end of the tube, so as to be air tight at the joining; the tube was then passed through a portable furnace, and an empty bladder mounted in the same manner fixed to its other extremity; heat was then applied to the middle of the tube until it became red, taking care at the same time to keep its extremities cold, by means of wet cloths wrapped round them. When the tube was sufficiently hot, the gas was made to pass slowly through it from the full bladder to the empty one, and then back again from the latter to the former. This was repeated ten times, when a little of the gas left in one of the bladders was examined, which by means of the stop cocks could be managed at pleasure. This gas was found to consist of one part inflammable gas, and two parts carbonic acid; the bladder was then re-applied, and the gas forced backwards and forwards ten times as before; on re-examination it was now found to consist of inflammable gas, and carbonic acid gas in the proportion of 11 to 5; but by continuing the process a little longer, no less than three fourths of the original carbonic acid gas was converted into an inflammable gas, and which on examination was found to be the true gaseous oxide of carbon; the wires after the tube

tube had cooled were examined, and found covered in ſeveral places with a beautiful ſhining cruſt of grey oxide, which readily crumbled and fell off on bending the wire. The carbonic acid employed in this experiment was procured from carbonate of ſoda by means of the dilute ſulphuric acid, and amounted to 64 ounce meaſures; during the proceſs very little diminution or increaſe of bulk could be perceived, which is readily accounted for, from the very trifling diminution the gaſeous oxide undergoes when converted into carbonic acid gas.

From the various facts which have been now enumerated, added to thoſe already known, there can no longer remain any doubt, that the carbonic acid, under certain elevations of temperature, may be readily decompoſed by any fixed ſubſtance, having a conſiderable affinity for oxigen; and that with regard to the metals, thoſe ſucceed the beſt which have the greateſt attraction for acids or oxigen, as is remarkably exemplified in zinc.

Upon the whole then I think we may conclude, that there are but two diſtinct combinations of carbon and oxigen capable of aſſuming and maintaining the form of gas; for although the gaſeous oxide may be obtained in a great variety of ways by direct compoſition, as well as the decompoſition of the carbonic acid, yet when pure it is exactly the ſame ſubſtance, having the ſame ſpecific gravity, requiring the ſame quantity of oxigen to ſaturate it, and producing uniformly the ſame proportion of carbonic acid. I remarked indeed formerly, that the gas obtained from charcoal (however well dried) mixed with the metallic oxides, always yielded a little water, when burned in a receiver containing common air or oxigen gas, and this impurity was aſcribed to hidrogen contained in the charcoal itſelf. Now that this may really be the caſe, appears to be in ſome degree confirmed by the following experiments.

A quantity of charcoal obtained by diſtillation in iron cylinders, was introduced into a retort without being moiſtened. A great quantity of gas was in all produced, what came over about the middle of the proceſs conſiſted of carbonic acid and hydrocarbonate in the proportion of 1 to 18.* Two meaſures of this waſhed hydrocarbonate required 1.6 meaſures of oxigen to ſaturate them, the products being one meaſure carbonic acid gas with water. Another portion of the ſame charcoal, which had for ſome time been expoſed to a red heat in a covered crucible, was introduced into a coated glaſs retort, and a ſtrong heat being applied, a conſiderable quantity of gas came over. This gas, except at the very commencement, ſcarcely contained a veſtige of carbonic acid; two meaſures of it required 1.25 of oxigen gas to ſaturate them, the products being water with only .55 parts of a meaſure of carbonic acid. Now by comparing theſe experiments together, it would appear that the gas from the charcoal which had been ſo completely deprived of its moiſture, contained bulk for bulk more hidrogen, and leſs carbon than the gas from that which had not been dried; this being the caſe, it can hardly be ſuppoſed that the hidrogen proceeded from the decompoſition of water, but muſt have ſomehow entered into the compoſition of the charcoal itſelf. The total abſence of carbonic acid may be conſidered as a further

* The gas obtained in this way is extremely variable, and towards the beginning of the proceſs I have ſometimes met with traces of the gaſeous oxide.

proof

proof of this. Another argument in favour of this fuppofition may likewife be drawn from the uniform lofs of weight which has been obferved in burning charcoal in pure air or oxigen gas; that is to fay, the weight of the carbonic acid produced has never been found equal to that of the oxigen and charcoal confumed; this deficiency I make no doubt, has arifen from the production of water which was afterwards held in folution by the carbonic acid gas, and could not therefore appear in its natural ftate. That moft gafes contain a large proportion of water at the common temperature of the atmofphere can hardly be doubted, although it may be very difficult to eftimate the quantity, for the drieft gafes expofed in clofe bottles to freezing mixtures, will be found to depofit a confiderable quantity of moifture, which will again difappear on raifing the temperature. It is not improbable, therefore, that water may be frequently produced without our being able to detect it. It is no doubt in a great meafure from this impurity in the charcoal, that all the gafes obtained from mixtures containing it, are fo uncertain and variable in their properties.

Woolwich, Aug. 19, 1801.

II.

*Short Notice concerning the Properties and external Characters of fome new Foffils from Sweden and Norway; together with fome Chemical Remarks upon the fame. By Mr. D'*ANDRADA. *In a Letter to Mr. Beyer, Mafter of the Mines at Schneeburg.*

(Concluded from page 196.)

IX. WERNERITE.

ITS colour is a medium between the piftaccia-green and Ifabella-yellow, of different fhades of yellow. Inwardly its luftre is of the fattifh kind, approaching to that of the mother-of-pearl, fometimes in a high degree refplendent, and fometimes a little chatoyant, but without any diftinct play of colour. In fmall fragments it is very tranfparent; and its fpecific gravity is 3.6063. It cuts glafs, but gives little fire with fteel, and can be fcratched by the common feld-fpar. Its texture is fomewhat curvilinearly foliated, and when the lamellæ are confiderably curvilinear, the fracture appears chatoyant. The laminæ feem to crofs each other twice in an oblique direction. The crofs fracture is uneven and fine fplintery; and its fragments are fplintery, with fharp edges and pointed. Wernerite occurs in maffes and cryftallized. The cryftals are low, hexahedral columns, with tetrahedral terminations, having their terminating faces impofed on the lateral edges. In thofe fpecimens, which are found in lumps or maffes, the form of aggregation is large and coarfe granular, and very much concreted. This ftone readily frothes upon charcoal before the blow-pipe, and its edges exhibit an opaque, white, imperfect enamel. It occurs in the iron-mines Northo and Ulrica, in the Arendal territory in Norway, and alfo in Campolongo, in the Lewindale, in Swifferland. This foffil bears great refemblance to the adamantine fpar in its colour and luftre.

X. PETALITE.

The colour moft frequently occurring is reddifh, and in fome inftances greyifh-white. Its internal luftre is ordinary and glittering, now and then with a little fplendor, and in that cafe of a faint appearance of mother-of-pearl. The edges are a little tranfparent. Specific gravity rather above 2.620. It cuts glafs and is itfelf fcratched by feld-fpar. It hardly ftrikes fire with fteel. It occurs in lumps of a fine and alfo of a rather coarfe aggregation. Its texture is foliated or fcaly. The lamellæ are very minute, throughout ftrongly concreted with each other. Their croffing is but fingle. The fragments of the crofs fracture are angular, amorphous, and not very fharp in the edges. It is broken with great facility, and eafily reduced by grinding into a fubtle, white, rough, and dry powder. When one piece is rubbed againft another, it emits a faint fmell refembling quartz. When treated alone with the blow-pipe it is infufible, without change of colour or luftre. With borax it produces a white, tranfparent, vitreous globule, and with microcofmic falt a yellowifh-white pearly glafs, full of fine air-bubbles. With nitric acid it does not effervefce, whether in the ftate of grains or of powder, but a portion is gradually diffolved by that acid. Petalite is found near Utoen, Sala, and Fingrufan, near Nyakoperberg, in Sweden.

XI. CHRYOLITE.

Colour fnow-white. Luftre faint, like a weak fplendor of mother-of-pearl. Very tranfparent. Specific gravity 2.9698. It fcratches calcareous fpar, but is itfelf fcratched by fluor-fpar. It may be readily broken in pieces, and is rather foft. It yields a very fubtle, white powder, of a foft feel, which, if moiftened with water, becomes tranfparent. This foffil feels dry, and is cold, like feld-fpar. Its texture thick and broad foliated, with an irregular roughnefs, like water that has been fuddenly congealed to ice. Its laminæ are ftraight, and their croffing threefold. The parts feparated by fplitting, when entire, are of a cubical form. The aggregation of its integrant parts is fuch, that the juncture of two is always covered by a third, fuper-impofed like bricks, which originates from the circumftance, that two croffings are ftraight and of the broad foliated kind, while the third is partly laminated, partly broken, partly uneven. Before the blow-pipe chryolite fufes even before ignition, like ice melting without effervefcence; and it yields a fnowy-white opaque pearly mafs, which by a ftronger heat becomes rough, full of bubbles, and depreffed in the middle, being alfo cauftic in that ftate when put on the tongue, and poffeffed of a tafte fimilar to that of borax. When heated with borax, this foffil is fufed to a pellucid glafs, which, however, upon cooling is opaque and white. When fufed with pot-afh in a filver crucible, it turns to a white porcelanic mafs; which, when diffolved in diftilled water, and precipitated by means of nitric acid, yields a white, tranfparent pafty mafs, which after deficcation may be fufed again in the fame manner as the crude foffil. In the nitric and

muriatic

muriatic acid it is insoluble. With very concentrated sulphuric acid it strongly effervesces, emitting then whiteish, gaseous vapours, which attack glass. This peculiar fossil consists of alumine, fluoric acid, and a little pot-ash. It occurs in Greenland, but its native particular spot is not yet known, though it appears to form strata.

XII. SCAPOLITE.

The colour of this stone is yellowish and greyish-white, and also smoky-grey. Its external lustre vitreous, from the gloss of wax to a brighter polish, but its internal lustre has little brillliancy. This stone is more or less transparent on the edges, but it is entirely opaque when decayed. Specific gravity from 3.680 to 3.780. It admits of being scratched with a knife, but itself scratches glass. Its streak is white. The crystals are nearly rectangular quadrilateral columns (having angles from 85° to 95°), with very slightly truncated lateral edges, without pointed terminations. These crystals are very minute, and in that case almost needle-shaped; seldom large, with transverse shootings, and longitudinally striated. The small and very small ones are usually concreted cross-ways with each other in regular clusters *(drusen)* and prismatic; but the larger are totally bedded in the matrix. Their texture is lamellar, but in the larger crystals it approaches to the striated. When split a visible diagonal crossing is perceived lengthways, and a second one less perceptible which is longitudinal and oblique-angular. The cross fracture of scapolite is uneven, and the fragments of this fracture are prismatic (bar-like). It may be easily broken, and is not electric. Before the blow-pipe it readily fuses, with frothing, into a white resplendent enamel. It is found in the iron-mines near Arendal, in Norway.

III.

Experiments and Observations on the Properties of Wind Instruments, consisting of a single Pipe or Channel; with Improvements in their Construction. By Mr. WILLIAM CLOSE.

To Mr. NICHOLSON.

SIR,

ON every wind instrument of music, which has the intervals of its scale regulated by holes for the fingers of the musician, it is impracticable to transpose the key of an air half a tone, without altogether changing the mode of fingering. If no alteration can be made in the length of the instrument, to perform a quick succession of chromatic intervals is not easy; but when some of the chromatic notes are assumed for the key of an air, the fingering is attended with so many difficulties, that the melody can only be well executed by a performer of transcendent abilities.

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The chromatic ſemitones are generally introduced into the natural ſcale of each of theſe inſtruments by the aſſiſtance of ſeveral fingers. If they could be all conducted by one finger, or if all the notes of the ſcale could be raiſed half a tone by opening only one aperture, a ſucceſſion of ſemitonic intervals could be attended with little difficulty. It would be eaſy to introduce any number of ſharp ſounds from another key, and as eaſy to play in the modes of C ſharp, D ſharp, F ſharp, and G ſharp with a greater third, as of C, D, F, and G; of G ſharp, D ſharp, and A ſharp, with a minor third, as in the eaſy keys G, D, and A; becauſe the ſcale in each key, with all its ſounds made ſharp, would be fingered in the manner as previous to its tranſpoſition.

The pitch of an inſtrument, indeed, may be raiſed by contracting its length, but this method can be of little uſe, except for making it accompany other inſtruments. It cannot be uſed in modulation to leſſon the difficulties of fingering, as the melody muſt be ſuſpended before it can be adopted.

Among ſome experiments which I have made with a view to improve the ſtructure of certain wind inſtruments, I have endeavoured to realiſe a project for a very eaſy method of introducing the chromatic ſemitones into the natural ſcale, and of ſharping any number of the diatonic notes at pleaſure: in the courſe of the preſent letter I ſhall communicate the method of doing this, and deſcribe the principal inſtruments which have been conſtructed in the courſe of theſe experimental reſearches.

In deſcribing the inſtruments I ſhall follow the order in which I have arranged the drawings.

Early in the year 1799, I had a large flute conſtructed of pewter, in the ſhape repreſented by Fig. 1, Plate XI. which is ſtill in my poſſeſſion. Its inſide is a winding cavity or ſerpentine tube, into which are made ſeven holes at very convenient diſtances for the fingers commonly uſed in performing the ſcale of C major on the German flute. When all theſe apertures are cloſed, the loweſt ſound is in uniſon with the note repreſented by the line which is marked F by the baſs cliff, or it is one-fifth lower than the loweſt ſound of a German flute, which has three keys for the little finger of the right hand.

Fig. 2 repreſents an horizontal ſection of the tube or cavity, at any height between its higher and lower ſides, on a ſcale of one-fifth of the real ſize. The inſide of the tube is three quarters of an inch broad, and one inch deep.

That part of the inſtrument which contains the aperture for producing the ſound, is laid over three turns of the tube, and is repreſented in Fig. 3, which is a vertical ſection of this part of the inſtrument, to ſhew the depth of the ſides, and the conſtruction of the tube near the ſound hole. A ſudden dilatation in this part is avoided, by the inſertion of a piece of metal, which produces the gradual turn, repreſented by the dotted line: but none of the corners in any other part are there cut off.

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Theſe pieces or plates of metal in this conſtruction of inſtruments of this kind, are bended and laid together in the manner delineated in Fig. 4, which nearly repreſents a croſs vertical ſection of the inſtrument between the ſound hole and the apertures for the fingers.

The length of the tube, and the places for the holes, were made to correſpond with the proportions of an inſtrument that was ſtraight, by meaſuring a line that was repreſented as drawn in the middle of the tube on a plan ſimilar to that delineated in Fig. 2, but of the real ſize. The line took a ſemicircular turn at the end of every partition, and deſcribed the half of that curve at five other places. The empty corners were all diſregarded in the oalculation.

The holes for the fingers are marked 1, 2, 3, 4, 5, 6, 7, in Fig. 2: the hole 8 is covered with a valve or key, which is depreſſed by the little finger when the inſtrument is required to ſound G ſharp; at all other times, when the aſſiſtance of the little finger is requiſite to ſteady the inſtrument, it is put down upon the ſeventh hole inſtead of being laid upon the key, as is commonly practiſed in playing the German flute.

That all ſounds of the ſame name ſhould be perfect octaves, is one of the firſt requiſites in the ſcale of every inſtrument. It was expected that the angles or dilated parts in the anfractuous ſtructure of this flute would render the octaves too flat, but when the ſeven loweſt ſounds were tuned by adjuſting the ſizes of the holes there was very little imperfection in each correſponding ſound of the ſecond octave. D and E, anſwering to A and B in the higher octave of the German flute, are thoſe that are a little defective: they are too flat when the ſeventh hole is open, but when it is cloſed they are made true. Cloſing this aperture does not affect D and E in the lower octave.

An inſtrument of this kind ſhould be made light, as it is generally ſupported in an horizontal poſition when applied to the lips, and the chief of its weight reſts upon the thumb of the left hand. The form may be uſed for large inſtruments when it is requiſite to contract the length, and bring the holes for the fingers into a convenient compaſs.

A flute of the ſame pitch with the German flute was conſtructed of the ſhape of Fig. 1, but the ſecond octave of its ſcale was very defective, even when every precaution had been taken to fill up all the corners.

A ſmall ſtraight flute, which is about four-tenths of an inch in diameter, thirteen inches in length from where it is filled with the cork, with ſeven holes for the fingers, and the neareſt of theſe to the ſound hole about five inches diſtant from its centre, will perform a ſcale of three octaves and a full tone, and will ſound B and either of its octaves when only the firſt hole is cloſed. The compaſs of the ſcale of a common fife with ſix holes is two octaves and a ſixth. The extenſion of the ſcale by a fife of theſe dimenſions beyond that of the common one is owing to the additional piece of tube beyond the ſeventh hole. As performers on the fife generally uſe the acuteſt ſounds of the inſtrument, it will be of advantage to make this addition, even when the ſeventh hole cannot be cloſed by the little finger: it will extend the ſcale, and make ſome of the acuteſt ſounds eaſier to be taken in ſucceſſion, by rendering the mode of fingering more ſimple.

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I had once a very ſmall metallic flute or fife which would play any two notes in the firſt and ſecond octave which were octaves to each other, both together, and when it was rightly blown they were perfectly in tune. The ſound hole was elliptical, and rather wide, and its edges were ſharp. The holes for the fingers were wide, and the ſides of the pipe were thin.

I ſhall now proceed to explain the method of tranſpoſing the key of an air on the German flute without any material alteration in the mode of fingering.

If one end of a round pipe, which is one-fifth of an inch in diameter, and two inches and an half long, be inſerted into the ſide of a German flute, about one inch and three quarters nearer the ſound hole than the aperture, which is uſually cloſed by the foremoſt finger of the left hand, all the ſounds in the loweſt octave from C to B will be raiſed half a tone while both its ends are open, and all, or any of them, may be reſtored to the original pitch by only cloſing its exterior orifice.

If the end of another pipe, which is rather wider than the former, and one inch and an half long, be inſerted into the flute between, and equally diſtant from, the fourth and fifth holes from the ſound hole, theſe ſounds of the ſecond octave C, D, E, will be raiſed nearly half a tone. When C is produced, only the ſecond hole from the ſound hole ſhould be open.

If the end of a third pipe, which is one quarter of an inch in diameter, and one inch long, be inſerted into the flute at the ſame diſtance from the ſound hole as the neareſt aperture but one, all the notes in the ſecond octave between C and C will be raiſed half a tone when all the three pipes are open.

To reduce this to practice: Let the firſt pipe be ſo laid by the ſide of the flute that the end which opens into the external air may be cloſed by the thumb of the left hand; and let the other two pipes be ſo diſpoſed that their ends may be cloſed by two valves or keys, which may be both opened at once by either the thumb or the little finger of the left hand.

Fig. 5 repreſents a German flute of the common ſize, which is chiefly conſtructed of tin and copper, and has the three additional pipes. A ſection of it is delineated in Fig. 6. The places of the holes for the fingers are there numbered 1, 2, 3, 4, 5, 6, 7. There is a turn in the tube between the ſixth and ſeventh holes, in order that the ſeventh may be cloſed by the little finger of the right hand inſtead of a key. The three pipes are arranged in the order that has been recommended. That for ſharping the notes of the lower octave is cloſed by the thumb, and the other two by keys, which are delineated in Fig. 5.

The flute is rather ſtraighter at the turn than in any other part, when it was not contracted between the ſixth and ſeventh holes; ſome of the ſounds in the ſecond octave, particularly F ſharp and G, were put out of tune when the ſeventh hole was cloſed.

When the above-mentioned pipes are added to flutes made of wood, they may either be let into the material, or formed by making grooves in the ſide of the inſtrument after it is lined with a metallic tube: theſe grooves may then be covered with pieces of metal, to which may be fixed the keys.

By the aſſiſtance of theſe pipes it is very eaſy to perform a chromatic ſcale, or at pleaſure to tranſpoſe the key of an air half a tone. The truth of the intervals in the key thus aſſumed depends very much upon the width of the pipes. Thoſe of the flute, delineated in Fig. 5 and 6, would be pretty true; but one or two octave notes of its original ſcale are too ſharp, and this imperfection is tranſmitted to the tranſpoſed ſcale.

To determine whether the original ſounds of the ſecond octave could be raiſed by cloſing the interior ends of theſe pipes, or (which would anſwer the ſame purpoſe in diminiſhing the internal capacity of the inſtrument) by filling them with water, I made the following experiment:

The three pipes were inſerted into that ſide of the flute oppoſite the holes for the fingers, and nearly at right angles with the tube. The lower end of each was then juſt immerſed in water contained in a ſmall veſſel, and while the flute was held in a poſition nearly horizontal, ſounding each of the notes C, D, E, F, G, A, B, of the ſecond octave, and C, D, E, of the third, the veſſels were raiſed ſo high, that the water would very nearly fill to the higher end of each pipe. No variation in any of theſe ſounds C, D, E, F, G, was perceptible: but the pitch of the five higher, A, B, C, D, E, roſe a little with the aſcent of the water. The variation, however, was ſo ſlight as to be no objection to the uſe of the pipes.

When an air is tranſpoſed out of D into D ſharp by opening theſe ducts, the key note of the original mode D muſt be uſed for the ſharp ſeventh of that which is adopted, inſtead of C ſharp, which, when fingered in the uſual manner, is too flat; for the ſame reaſon it is alſo preferable in the ſcale of D ſharp, to uſe the common C inſtead of B ſharp for the major ſixth major; and when an air is tranſpoſed out of middle C into C ſharp, to uſe the common C ſharp for the key note.

Theſe, and ſome other defects, induce me to think that the following method of tranſpoſition by one pipe will be moſt eligible, as the fingering of the ſcale in any common key need not be altered.

Inſert one end of a round pipe, three-tenths of an inch in diameter, and one inch long, into the inſide of a German flute, ſo much nearer the holes for the fingers than the ſound hole, that a line which encircles the flute, and paſſes through the middle of this laſt hole, may be ſeven-tenths of an inch from the centre of the interior orifice of the pipe, and all the ſounds of the flute will be raiſed about half a tone when the ends of the pipe are open. Turn this pipe by the ſide of the flute, and let its exterior orifice be cloſed by a valve or key, which may be opened by the thumb of the left hand.

In the model with which I made the experiment, the pipe was inſerted into the contrary ſide of the flute to that into which it ſhould be inſerted, when the inſtrument is intended for practice: it is delineated in this poſition by the two dotted lines in Fig. 6. I have not had an inſtrument conſtructed upon this plan, but I think it much preferable to the method propoſed before. The flute may have all the common keys, and the fingering of no ſcale

will require any change after it is tranfpofed a femitone higher. The B flat key, however, cannot be ufed in fcales that are tranfpofed; but there will not be much occafion for it at all, as the long key here recommended will fupply its place, and be as eafy to manage.

The pipe delineated by the two dotted lines in Fig. 6, was filled with water while each note of the flute was founding, but the variation produced in one or two notes of the fecond octave by the afcent of the water was fcarcely perceptible. Entertaining fome doubt, however, that B and its octave were not perfectly in tune with each other, I compared them both with two correfponding founds of an organ which were perfect octaves. The higher found of the flute was a true octave to the found of the lower toned organ pipe, but the lower was rather too fharp to be exactly in tune with the found of the higher pipe, unlefs the flute was carefully blown. After the tranfpofing tube was removed, the relation between thefe two laft founds was little amended.

The octaves of A and B, rendered fharp by opening the end of the pipe, were as true as the octave founds of German flutes are generally found to be when compared with other founds which are perfectly in tune. Without making any further remarks on this method of tranfpofition, I fhall proceed to other objects.

Wind inftruments of mufic, which have their notes regulated by feveral apertures, will generally produce two or more founds, differing confiderably in acutenefs from one another, when all their holes are clofed, or when any number of them are open, if the ftrength of the current of air employed in founding the inftrument be gradually increafed. All the founds in any feries thus produced above the loweft of the feries, are called harmonics: thus when C is the loweft found of a German flute, the harmonics are *C*, *G*, *c*, *e*, *g*.

In the fcales of the flute, the oboe, clarionet, and other inftruments, a fucceffion of the loweft founds in diatonic order are produced by opening feveral holes, until the higheft is only a tone or half a tone lower than the loweft harmonic of each inftrument with all the holes clofed. This harmonical found is then taken into the fcale, and another feries is produced by opening the holes a fecond time, while the current of air is accelerated.

On the flute and the oboe thefe latter founds, the afpiring offspring of thofe below, fhould be each an octave to its progenitor, but on the clarionet each fhould be a twelfth. The number of apertures that will be required to complete the lower feries, depends upon the number of diatonic notes which compofe the interval between the loweft found of the inftrument and its loweft harmonic: each note included between thefe muft have an aperture to regulate its pitch. When the interval is an octave, fix holes will fuffice for this purpofe; but when it is a twelfth or compound fifth ten muft be employed.

The requifite pitch of each note is obtained by adjufting the fizes of the holes, and making them dilate confiderably as they approach the infide of the inftrument. We have before noticed the effect of opening a pipe which was all throughout of the fame width, connected with the infide of a flute, and from what has been faid, it is eafy to underftand

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why this ſhape in the holes is ſo univerſally adopted. As every aperture muſt regulate two ſounds, it may juſtly be conſidered a deſirable requiſite, that the width of every wind inſtrument ſhould be ſo proportioned, that the interval between each of thoſe ſounds produced with the leaſt effort, and theſe propagated by increaſing the force of the current, ſhall equal either an octave or a twelfth. Several adventitious circumſtances, however, often deſtroy the harmonical relation which might otherwiſe reſult from the dimenſions of the tube.

The harmonical part of the ſcale of the German-flute is nearly true, bnt the ſame part of the ſcale of thoſe inſtruments, whoſe ſounds are propagated by the vibrations of a piece of reed, are generally very imperfect. I ſhall only make a few obſervations reſpecting the clarionet, as I have made no experiments with any other inſtrument of this kind.

The pitch of the higher notes in the ſcale of the clarionet depends very much upon the ſtrength of the reed, when the inſtrument is only blown, and the reed not preſſed by the lips of the performer. A reed that is ſtrong enough to perform the higher ſounds in tune, unaſſiſted by preſſure, will ſoon fatigue the performer, and ſcarcely play the ſounds of the lower ſcale: on the contrary, a reed that is ſlender enough to play the loweſt ſucceſſion of ſounds full, will not play the ſcale of twelfths true, unleſs it be preſſed ſtrongly by the lips, and if any of the holes are widened ſo much as to produce the requiſite pitch in the harmonical ſound, then its progenitor will be made too high, compared with another ſound which ſhould be its octave: thus it happens, that adjuſting the ſizes of the holes to the ſounds in one part of the ſcale, deſtroys their conformity in another part. It is however abſolutely neceſſary, that the octaves ſhould be true, and that the reed ſhould be ſo ſlender as not to fatigue the performer; and therefore the higher ſounds are generally made in tune with the lower, by preſſing the reed—a method which is not agreeable, and requires much practice to regulate.

If every aperture of an inſtrument only regulated the pitch of one ſound inſtead of two, the temperament of the ſcale might be eaſily adjuſted, but from the limited number of holes that can be conveniently managed by the fingers, a ſeries of diatonic notes could ſcarcely be carried through two octaves. An inſtrument upon this principle, I have frequently thought however, would ſerve very well for performing the baſe, or ſome part between the baſe and the treble, accordingly I have couſtructed one in the ſhape of Fig. 7, with a reed like a clarionet.

Fig. 8. is a ſection, which contains the proportionate length and breadth of the inſtrument upon a ſcale of one fifth of the real ſize. The inſide of the tube A is five lines in breadth, and ſeven in depth. To this tube is fixed the piece which carries the reed, and two other pieces or branches B and C, which have the ſame dimenſions as A. There is alſo a ſmall pipe repreſented under the figures 1, 2, 3, 4, which opens into this tube. The inſtrument has nine apertures on its higher ſide marked 1, 1, 2, 3, 4, 5, 6, 7, 8, which are cloſed by the fingers; and two on its under ſide marked 9, 10. The ninth hole is cloſed by a valve or key, and the tenth by the thumb of the left hand. The end of the ſmall pipe

 at

at 5 opens on the under side, and is closed by the thumb of the right hand. The holes marked 11, 12, are always open, they are on opposite sides of the tube, and let out the air when all the other apertures are closed.

The lowest sound of the instrument is C, represented by the second space under the line marked F by the base cliff. The sounds D, E, F, G, A, B, *C*, *D*, *E*, *F*, are produced by opening the holes 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 1, and these are all the notes that can be conveniently obtained in this manner, unless there be a key for the foremost finger of the left hand to add *G*, which sound however, is as easily produced by closing all the holes except those marked 1, 1; after this, by opening the hole 8, while 1, 1, are open, the next note *A* will be added to the scale. Other notes still higher may be thus obtained, but they are not so easy to command. The small pipe under 1, 2, 3, 4, is made of a thin piece of brass; it is flat, and forms part of one side of the tube A; if it was round, it would be two lines in diameter. When any of the chromatic semitones between C and *G* are introduced, the end of the pipe is opened, and also if it is requisite to change the key of C for that of C sharp.

The holes marked 1, 1, are each in a different part of the tube, but as they are only separated by the thin division between the tubes A and C, they are as easily closed by the foremost finger of the left hand as one hole. When the aperture 1 in the tube A is only open, the sound *G* is too flat, but when the hole 1 in the branch C is also opened, it is a true twelfth compared with the lowest sound of the instrument, although the second sound, which is produced by strengthening the current of air when all the holes are closed, is only a compound fourth.

The branch B brings the hole 7 conveniently under the little finger of the right hand. The width of a part of this branch is contracted by the insertion of a thin plate in the inside, as is faintly represented in Fig. 7.

The hole 8 is closed by the little finger of the left hand: it is made wide, that the sound F may be true when the holes 9, 10, are either closed or open. The length of the reed, and the slanted surface of that part over which it is placed, may be determined by the lines drawn under Fig. 8. the higher line represents the flat side of the reed, the lower shews the inclined surface of the instrument.

This instrument is portable and easy to play; the intensity of its tone may be varied without any variation in its pitch; it requires a piece of reed which is very slender, and may be shaped in a few minutes. The scales of C and F major, and A and E minor will perform the best, but these may be transposed half a tone by opening the small pipe under 1, 2, 3, 4. The music may be written with the C cliff placed upon the lowest line but one of the stave.

The compound fourth produced by this instrument in place of the twelfth or compound fifth, suggested an alteration in the scale of the clarionet, namely, by a slender reed to substitute a scale of elevenths, or even tenths in place of the succession of twelfths.

Fig.

Fig. 9 repreſents a metallic clarionet, which was conſtructed for this purpoſe. It will perform the notes of a diatonic ſcale to the extent of two octaves and a fourth. The common holes for the fingers are marked 1, 2, 3, 4, 5, 6, 7 : between 3 and 4 there is an additional hole for the little finger of the left hand, and about half an inch nearer the reed than the firſt, and on the oppoſite ſide of the tube there is an aperture for the thumb. The proportions of this figure are equal in length to one fourth of thoſe of the inſtrument. The tube is five eighths of an inch in diameter beyond the figure 7 ; at 1 it is about half an inch. The loweſt ſound of the inſtrument with all the holes cloſed, is G repreſented by the ſpace immediately above the line, which cauſes the baſe cliff. When the inſtrument is blown eaſily, and the holes 7, 6, 5, 4, *llfh*, 3, 2, 1, *th*, are opened one after another, the following ſucceſſion of notes will be produced, A, B, C, D, E, F, G, *a* B : when the hole 5 is opened for C, 6 ſhould be cloſed. For B flat, cloſe the hole 1 while the thumb hole is open. For C the compound fourth of the loweſt ſound G, cloſe all the holes except the firſt and the thumb hole, or either of them. While blowing a little ſtronger cloſe theſe, and open the holes in the ſame order as for A, B, C, D, E, F, G, A, B, and the following ſucceſſion of ſounds will follow, D, E, F, G, A, B flat, B, C. If the higheſt C be too flat, open the thumb hole and cloſe the ſecond. Another ſound ſtill higher may be added, by preſſing a key with the foremoſt finger of the left hand. The compaſs of the ſcale will then be equal to two octaves and a fifth. A ſmall pipe might be introduced into the ſide of the inſtrument oppoſite the ſeventh hole, and its exterior end cloſed by the thumb of the right hand ; when it is opened the loweſt ſound G, and C its compound fourth, will be raiſed half a tone. It would alſo be advantageous to have a joint near the wider end of this clarionet to vary the pitch of middle C, in the modes of C and F ; when this note is raiſed a little, its octave below may be made true by opening the ſixth hole. An inſtrument of this kind may be made of wood. It ſeems well adapted for performing the parts generally aſſigned to the *firſt* clarionet. All the ſounds of its ſeale are nearly of an equal ſtrength. The fingering of its ſcale is eaſy, as none of the common notes are introduced by opening apertures which are cloſed by inanimate valves or keys. The reed is ſlender, and requires little preſſure from the lips in performing the higher ſounds of the ſcale. Keys are not neceſſary in the diatonic ſcales of C and F, but for introducing F ſharp in the lower ſeries of notes, and E flat in the higher, two keys will be of advantage. A baſs inſtrument as long again as this clarionet, with the ſame kind of a reed, and with the holes for the fingers diſpoſed in the ſame order, may be made in a ſerpentine form like the part 1, 2, 3, 4, 5, 6, in Fig. 2, but if it be intended to perform an extenſive ſcale, all dilated parts ſhould be avoided, or the ſounds in the higher ſeries will be too flat when produced by a ſlender reed.

I ſhall finiſh this long letter with an explanation of the tenth figure. When the external air is excluded from the ſide aperture of an organ pipe, and the ſound is carried with the current which produces it, through another pipe of the ſame dimenſions as that which determines

determines the pitch, the found is confiderably weakened, and its pitch is raifed. Fig. 10, reprefents the fection of the inftrument with which I made the experiment. It confifts of two pipes A and B. A fquare pipe was conftructed of metal, with an aperture in one fide like thofe pipes of an organ in the flute ftop. When its end was open its loweft found was in unifon with G above the fifth line of the treble ftave.

A thin piece of metal was now turned over three fides of the piece of wood upon which the pipe A had been turned, and its edges were foldered to two corners of that pipe. Two tubes being thus conftructed, the aperture for producing the found was in the partition between them. When that end of the tube B which is neareft the fide aperture was clofed, and the inftrument was blown, its tone was confiderably changed, and a full note higher.

An inftrument of this kind may be ufed when any of the gafes are employed in the production of found.

The harmonical founds of this pipe are A, octave to its loweft found; E, twelfth; A, double octave or fifteenth; and C fharp, feventeenth major. I confider the change in its original tone and pitch to be owing to the diminution of preffure upon the fide aperture. Flame produces nearly fimilar effects. Bring the flame of a candle very near the fide aperture of a fmall organ pipe, and its found will rife confiderably.

I think a mufical inftrument might be formed upon a plan nearly fimilar to that of Fig. 10. After the proper length of the pipes A and B is determined, fix holes may be made into each, fo near the partition, that all the twelve may be clofed by fix fingers.

Our fmall wind inftruments have many imperfections, but are the objects of fo little direct importance to fociety, that we do not expect much celerity in their improvement.

I am, SIR,

Your humble Servant,

WILLIAM CLOSE.

Dalton, July 24, 1801.

IV.

On the Production of artificial Cold by Means of Muriate of Lime. By Mr. RICHARD WALKER. (*Philof. Tranf.* 1801.)

THE fubject of the means of producing artificial cold, or the conftitution of frigorific mixtures, I had confidered as exhaufted, in the Papers I have already had the honour to lay before this Society: fo far as relates to that part of the fubject which confifts in generating artificial cold *without the ufe of ice*, it ftill remains fo with me, having nothing new to offer.

A con-

A conſiderable acquiſition however having been made, ſince my laſt Paper " On the beſt Methods of producing artificial Cold,"* by the diſcovery that a neutral ſalt, but little known, or attended to, by chemiſts before, produced extraordinary effects of this kind with ice, it could not fail of attracting my attention.

Since the time I firſt became acquainted with this circumſtance, I have, as opportunity offered, been engaged in making a variety of experiments with this ſalt, which I flatter myſelf, if the Society have not already received a communication on the ſubject, may not prove unacceptable.

Before I relate my own experiments, it may be proper to premiſe a ſhort account of thoſe of Mr. Lowitz, the author of the diſcovery.

The reſult of Mr. Lowitz's experiments are, in *his* Memoir, † given according to the ſcale of Reaumur; but, in *this*, are throughout reduced to that of Fahrenheit.

Mr. Lowitz, profeſſor of chemiſtry in Peterſburgh, having found, by an experiment made in the winter of 1792, that cauſtic vegetable alkali, in a ſolid ſtate, produced a degree of cold far exceeding any other ſubſtance before mixed with ſnow, *viz.* 83 degrees, determined to proſecute the ſubject; and, upon reflection, conſidering that the deliqueſcent ſalts were likely to be fitteſt for his purpoſe, fixed chiefly upon the claſs of muriatic ſalts, or thoſe which have their baſe neutralized by the muriatic acid. The reſult of his experiments was the diſcovery, that cryſtallized muriate of lime ſunk the thermometer 82 degrees; and that the other neutral ſalts of this claſs, though much inferior to that ſalt, exhibited neverthelesſ remarkable powers of the ſame kind. ‡

Profeſſor Lowitz, in the Memoir alluded to, obſerves that he has repeated my experiments with chemical ſalts and *ſnow*, but could not produce a degree of cold below + 2°. Here is evidently ſome miſtake; for it is ſufficiently known, that the novelty of my experiments depends on the production of cold, *without the uſe of ice* in any form. §

Pr. Lowitz having found by experiment that, at the temperature of + 27°, *four* parts of muriate of lime to *three* of ſnow produced a temperature of — 55°, and that an increaſe of the ſalt, even in the proportion of two to one, did not diminiſh the effect, determined the beſt and *ſureſt* proportions to be, three parts of the muriate of lime to two of ſnow.

But, ſince we ſhall find hereafter the temperature of + 32° to be a more convenient term of compariſon, we may fairly ſtate the fact thus; that muriate of lime three parts, and ſnow two parts, mixed at the temperature of + 32°, will give — 50°.

The ſnow, to produce the greateſt effect, he ſays, ſhould be freſh-fallen, dry, and light or uncompreſſed; and the ſalt perfectly dry, and reduced to very fine powder.

* Phil. Tranſ. for 1795, p. 270.

† See a tranſlation from Crell's Chemical Annals for 1796, by Monſ. Van Mons, Vol. XXII. p. 297, of the *Annales de Chimie.*

‡ Profeſſor Lowitz no ſooner diſcovered the great efficacy of the muriate of lime for this purpoſe, than he gladly rejected the cauſtic vegetable alkali, on account of its burning quality; the difference being *one* degree only.

§ See the table of frigorific mixtures. Phil. Tranſ. for 1795, p. 279.

Pr. Lowitz's method is, to add at once the falt to the fnow; the latter being previoufly put into a convenient veffel. As the falt produces the greateft effect whilft it retains the greateft quantity of water of cryftallization, he prepares it during a freezing atmofphere, pounds it, fifts it, and keeps it in clofe bottles, in a cold place. With a mixture of this kind, Pr. Lowitz froze, in one experiment, 35 pounds of quickfilver.

Pr. Lowitz obferves, that with the above precautions and management, it is impoffible to fail in the defign of freezing quickfilver with it.

Pr. Lowitz found likewife, that the muriate of lime, prepared as above, produced 38 degrees of cold by folution in water; that is, by adding 3 parts of this falt, in powder, to 2 parts of water, each at the temperature of + 36°½, the thermometer funk to — 1°½.

Pr. Lowitz adds, that the muriate of lime which has been ufed for making frigorific mixtures, may be procured again repeatedly, as fit as at firft for the fame purpofe, by evaporation and cryftallization. *

Having given an account of Pr. Lowitz's experiments, I fhall now briefly relate the refult of a feries of experiments made by myfelf, which occurred to me in confequence of Pr. Lowitz's difcovery.

My firft object was, to repeat the foregoing experiment under fimilar circumftances; but the thermometer (the temperature of the air and materials being + 32°) funk, in this inftance, no lefs than — 48°.

The liquefaction, in the above inftance, was remarkably fudden; and the full effect was produced, as it were, in an inftant.

Secondly, with a view either of producing a very extraordinary degree of cold, or afcertaining the point at which this falt ceafes to produce further cold, I mixed the fame materials, previoufly cooled by art to 40° below 0, when the thermometer funk to 63° below 0. †

Thirdly, fome of the fame falt, in a cryftallized ftate, was fet out to deliquefce in the open air: this liquor mixed with fnow, each at the temperature of + 32°, gave a cold of — 20°.

Hence it appears, that 52 degrees of heat were abforbed, or rendered latent, by the liquefaction of the fnow, and 28 by that of the falt, in the firft experiment; that is, in the whole, 80 degrees.

The muriate of lime ufed in the above experiments was prepared thus: muriatic acid 1 part, and diftilled water 3 parts, were thoroughly mixed; this liquor was then perfectly faturated with whiting, and, when clear, poured off. The mixture was afterwards evaporated, till it cryftallized in air at + 32°, (which happened when the liquor had been evaporated to the confiftence of a thin fyrup,) and then reduced to fine powder.

* The muriate of lime made ufe of by Profeffor Lowitz, in thefe experiments, was obtained from the refidue after the diftillation of cauftic ammonia.

† In this inftance, as I afterwards found, the proportion of fnow, owing in part to a confiderable portion of the muriate of lime remaining frozen at the bottom of the veffel, and not mixing, was much too great.

From

From the preceding account it is apparent, that Pr. Lowitz has discovered a single frigorific mixture, by which quicksilver may be frozen whenever the temperature of the materials at mixing is no colder than + 32°; whereas, the *nitrous acid* with snow, which has hitherto been considered as the most powerful of frigorific mixtures, requires a temperature of + 7°, to produce the same effect.

At the same time, however, it should be observed, that an experiment with this salt, prepared as above, can be made only *during a freezing atmosphere*; the salt itself thus prepared, becoming, as may be inferred from the above, and as I have myself experienced, unfit for use by a warmer temperature.

Reflecting upon my former experiments, I determined to try the effect of this salt, reduced to such a strength, by evaporation, as to endure being kept, in a solid state, throughout the year. For this purpose, I found it necessary that the liquor, prepared as before, should be evaporated to the consistence of a thickish syrup, before it is set by to crystallize; when the produce will be a semi-transparent, uniform, crystalline mass, which affords, on pulverizing, a white pearl-coloured powder, which should be preserved for use in a bottle closed with a ground stopper.

Some of the powder above mentioned, (which had been previously subjected to a temperature of + 70°, without melting,) I mixed with snow, each at the temperature of + 32°; when the thermometer, to my perfect satisfaction, sunk to — 40°; and, at another time, when the air was + 20°, I froze quicksilver perfectly solid, by a mixture of the same materials.

It appeared reasonable to expect that the power of this salt for producing cold, might be assisted by the combination with, or addition of, other salts, as has been found to be the case in other instances, to a considerable degree; and, conceiving from my former experiments, that the muriate of soda and nitrate of ammonia promised the greatest success in this way, these alone producing with snow a cold of — 25°, I was naturally led to combine these with the muriate of lime; but I obtained no advantage by this, or by any other means, worth noticing. *.

In the course of last winter, and the summer preceding, I repeated my former experiments with more accuracy; and likewise made some additional ones, on the power of muriate of lime for producing cold with ice, the result of which I shall here briefly state.

In order to reduce the experiments made with the muriate of lime to a greater certainty, I carefully obtained the respective specific gravities to which this salt should be reduced by

* M. Van Mons tried the effect of the caustic soda (which alone produces a cold of — 15° with snow) combined with the muriate of lime, and found the effect increased very considerably. By this means, he says, " In my new experiments on the effects of artificial cold, I have carried it to — 53°, old division"; (viz. 87° of Fahrenheit.) He does not mention the temperature at which the materials were mixed, to produce this effect.---M. Van Mons effects a chemical union of these two salts thus: he slakes quicklime with a solution of muriate of soda; this mixture, when become cold, he filters, and afterwards evaporates, until when cold it will become solid. *Annales de Chimie*, tom. XXIX.

 evaporation,

evaporation, before it be set by to cool, in order to become solid, in either instance: thus, when the muriate of lime is to be of that strength which is to be prepared and used at the temperature of + 32°, the specific gravity of the liquor should be, at the temperature of + 80°, 1,450; and when of that strength to be *kept* and used at the ordinary temperature of the air at any time, the specific gravity of the liquor should be 1,490, at 80° of heat.*

The liquor, when sufficiently evaporated, should be set by to crystallize; and the crystallized mass, as soon as cold, should be reduced to very fine powder, in a glass or stone mortar. The muriate of lime, in its solid state, being a hard brittle substance, it is necessary commonly to immerse the vessel containing it in water sufficiently warm to loosen the mass, in order to remove it out of the vessel, to pound it.

When the muriate of lime is intended to be preserved for future use, the powder should be put directly into a bottle, and closely stopped from the air; for this salt is extremely deliquescent, and hence, a dry state of the atmosphere should be chosen for preparing it.

These experiments I shall divide into two series; the first of which consists of those made with the muriate of lime prepared so as to be used in *winter* only, that is, of the strength of 1,450.

The second series consists of those made with the same salt prepared so as to be kept for use at any time, the strength of which is 1,490.

SERIES I.

Exp. 1st.	Muriate of lime	3,	Snow	2,	at + 32°	gave — 50° †
2d.	——— ———	2,	———	1,	0	— 66
3d.	——— ———	3,	———	1,	40	— 73
4th.	Diluted vitriolic acid	10, ‡	———	8,	68	— 91 §

SERIES

* Muriate of lime evaporated to the strength of 1,400, gives (if cooled slowly in a cold air, *viz.* + 20°) perfect crystals; this is the fittest state of the salt for producing cold.

† This experiment being repeated, using ice-powder, (instead of snow,) gave—51°;——that is, ice ground to very fine powder with the instrument described in Phil. Trans. for 1795, page 288. (Philos. J. I. 498.)

‡ Concentrated vitriolic acid 8 parts, water 4 parts, and rectified spirit of wine 1 part, mixed and cooled previously to the temperature of the air.

§ This experiment was made on the 10th of March last, and conducted by a series of three mixtures, thus. The materials for the *second* mixture, consisting of muriate of lime and snow, separated from each other by an intervening stratum of fine sand, were cooled in a large vessel, having a partition in the middle forming it into two compartments, to near 40° below 0, by means of a *prior* mixture of the same materials. The materials for the *second* mixture, cooled as above mentioned, were then mixed in each compartment of this double vessel, and let through an aperture at the bottom of each, (closed till then by a temporary partition,) into such an apparatus as that represented in the drawing, which contained the materials for the *third* or last mixture, consisting of the diluted vitriolic acid and snow, which had already been separately cooled in their respective vessels, to near 40° below 0.

The

SERIES II.

Exp. 1ſt.	Muriate of lime - - 5,	Ice-powder - - 4,	at + 32°,	gave — 41 *
2d.	——— ——— - - 4,	——— - - 3,	- - 20	- - — 48
3d.	——— ——— - - 4,	——— - - 3,	- - 10	- - — 54
4th.	——— ——— - - 3,	——— - - 2	- — 15	- - — 68

In the firſt experiment, the materials were mixed at the temperature of the air.

In the ſecond, they were previouſly cooled, by a mixture of muriate of ammonia, nitrate of pot-aſh and water; temperature of the air 52°; the ſalts which formed the preparatory mixture being recovered for uſe again, by evaporation.

In the third, they were cooled previouſly, by a mixture of muriate of ammonia, nitrate of pot-aſh, ſulphate of ſoda, and water; temperature of the air 50°. And,

In the fourth, by a mixture of phoſphate of ſoda, nitrate of ammonia, and diluted nitrous acid; temperature of the air 49°. †

Having concluded my experiments with the muriate of lime and *ice*, I proceeded to try the effects of this ſalt, prepared ſo as to retain its ſolid ſtate during ſummer, *viz.* of the ſtrength 1,490, by ſolution in *water*; and found that a mixture of this kind, produced twenty-nine degrees of cold; for, by adding 5 parts of the muriate of lime, in fine powder, to 4 parts of water, each at the temperature of + 50°, I obtained a cold of + 21 : this effect was not improved by the addition of other ſalts.

Theſe experiments were made in ſuch an apparatus as I am going to deſcribe, which may at firſt appear new, but, upon examination, will be found to be only a different modification of the veſſels repreſented in Fig. 3 and 4, Tab. XXIII of Phil. Tranſ. for 1795; (Philoſ. J. I. Plate XX.) and appears to me to have all the advantages that can be obtained in an experiment of this nature.

The thermometer repreſented in the drawing was then placed in the tube of the upper veſſel; and, when the ſnow was cooled to the utmoſt, *viz.* to near 70 below 0, the cooled ſnow was forced through into the cup containing the acid, the veſſels were ſeparated, and the ſnow and liquor thoroughly mixed by means of the thermometer contained in its glaſs tube; the thermometer was then withdrawn from the tube, and ſtirred about in this laſt or third mixture, which, in ten ſeconds of time, indicated a cold of 91°¼ below 0; twenty ſeconds more elapſed before the thermometer began to riſe. The mouth of the cup in the veſſel B was, in this inſtance, cloſed with waxed paper, in order that I might invert the veſſel occaſionally, to renew the mixture in it; and the cup itſelf was coated within-ſide with wax, in order to defend it from the action of the acid.

* The ſame experiment made at + 32°, with ſnow, (inſtead of ground ice,) gave — 40°.

† The compoſition and application of theſe frigorific mixtures are given in Phil. Tranſ. for 1795.

(To be concluded in our next.)

 Directions

V.

Directions for extracting Gum from the Lichen, or Tree Moss, &c. By the EARL OF DUNDONALD.*

IT does not appear from such trials as Lord Dundonald has hitherto made, that there is any very great difference in the produce of gum from the lichen collected from different trees or shrubs: all of them answer equally well for yielding a gum fit for calico printing. The lichen is most abundant on the trees which grow in a poor, stiff clay soil, particularly if situated at some considerable height above sea-level. It should be pulled in dry weather, otherwise it is apt to break in the pulling; besides, in this case, requiring to be dried, before it can with safety be laid up in the storehouse, where, if put in dry, it may be kept for years. Should a sufficient quantity of it not be found in this country, it may be had in almost unlimited abundance in Sweden, Norway, and in the northern parts of America, where it grows to the length of from a foot to eighteen inches, depressing the branches of the tree by its weight. There is, however, every reason to believe that a sufficient quantity is to be had in this country. According to information from Dr. Brown, lecturer on botany, it takes three or four years in coming to maturity or its full size, so that a crop from the same tree may be had every fourth year.

The lichen does not consist entirely of a gummy matter. There is the outer skin or cuticle, below that a green resinous matter: the remainder of the plant consists of partly gum, partly a matter somewhat analogous to animal substances, and a small proportion of fibrous matter, which cannot be dissolved by boiling, or the action of alkaline salts.

The first process in preparing gum from the lichen is to free it of the outer skin of the plant and the resinous matter. This is done by scalding the lichen two or three times with boiling water, allowing it to remain so long in the water, as by absorbing it to swell; in doing this the skin cracks and comes off along with the greatest part of the resinous matter. Or it may be freed from them by gently boiling the lichen for about fifteen or twenty minutes, then washing it in cold water, laying it afterwards upon a stone or brick floor, where it should lie for ten or twelve hours, or perhaps more. The reason for this is, that the exposure for that time to air greatly facilitates the subsequent extraction of the gum.

The scalded lichen is then to be put into a copper boiler, with a due proportion of water, say three Scotch pints, or two wine gallons, to every pound of lichen, and boiled

* Early in the present year this Nobleman convened the calico printers of Scotland, and communicated to them this important discovery, at a meeting at Glasgow, where several resolutions were made for the purpose of securing its advantages to the country, with a proper reward to the inventor. The present paper was printed at Glasgow, in six pages duodecimo, 1801. The statement which follows was also drawn up by his Lordship, by whom I was favoured with both.

during four or five hours, adding about half an ounce or three quarters of an ounce of ſoda or pearl aſhes for every pound of lichen; or, inſtead of theſe ſalts, about half an Engliſh pint of volatile alkali. The boiling ſhould be continued until the liquor acquires a conſiderable degree of gummy conſiſtence. It is then to be taken out of the boiler, allowed to drain or drip through a wire or hair cloth, or ſearſe. The reſiduum to be put into a hair cloth bag or bags, and to be ſqueezed in a preſs ſimilar to that which is uſed by the melters or rinders of tallow.

The firſt boiling does not extract the whole of the gum. The lichen ſhould be boiled a ſecond and even a third time, repeating the proceſs as above deſcribed, diminiſhing at each proceſs the quantity of water and the quantity of alkali, which a little experience will ſoon point out. When three boilings are employed, the gummy extract of the laſt boiling ſhould be kept for the firſt boiling of a freſh batch of lichen. The extract proceeding from the firſt and ſecond boilings ſhould be mixed together, and evaporated to the conſiſtence neceſſary for block or preſs printing. The evaporating veſſels ſhould be of tin or thin lead placed over a range of ſtoves and moderately heated by fire or the ſteam of water. It has been neglected to ſtate, that before evaporating the gummy extract to the conſiſtence neceſſary, it ſhould be kept ten or twelve hours, ſo as to allow the ſediment or dregs to ſubſide. The clear liquor may either be drawn off by a ſyphon, or the dregs may be drawn off by a cock at the bottom of the wooden veſſel; the bottom of which ſhould be made ſloping, higher at the back than the fore part, in order that the dregs may run more completely off. The proportion of gummy matter remaining in the dregs may be got off by mixing them with a due proportion of boiling water, allowing the liquor to clear, and proceeding as above directed, employing this weak ſolution for boiling the next batch of lichen.

The reſiduum of the lichen, after the third boiling, conſiſts of a matter ſomewhat analogous to that of animal matter, together with a proportion of the fibrous matter of the plant. From the animal matter a kind of ſoap may be made. The proceſs is as follows:

Let a ſmall proportion of pounded roſin be diſſolved by boiling in a ſolution of alkaline ſalts. When the roſin is diſſolved, put in a certain quantity of the reſiduum of the lichen, and continue the boiling until this laſt article is pretty well diſſolved. Then add about a pound or a pound and a half of white ſoap ſhaved down or cut into thin ſlices to every ten pound weight of the reſiduum of the lichen. Continue the boiling until the white ſoap is fully diſſolved. Then paſs the ſoapy ſolution through a hair ſieve or hair bag. Let the ſoap pan then be cleaned out and the ſoapy ſolution returned to the pan, to be boiled to the conſiſtence neceſſary. A kind of ſoap very ſimilar to this may be made from ſea weed, as well as from ſeveral other articles. Of this and of other matters, highly important to calico printers, a more full and detailed account will be given in a future publication. When gum from the lichen is to be employed for making ink, manufacturing and ſtaining paper, and

and for ſtiffening ſilks, crapes and gauzes, it ſhould be extracted from the lichen without employing any alkaline ſalts, continuing the boiling or digeſtion longer, and with a moderate degree of heat, in which caſe the gummy extract will be nearly colourleſs.

When volatile alkali is uſed, the boiler ſhould be of iron, as volatile alkali acts on copper.

Statement of the Benefits and Advantages to enſue to Individuals and to the United Kingdom of Great Britain and Ireland, from Lord Dundonald's Diſcovery of extracting Gum from the Lichen, or Tree Moſs, as a Subſtitute for Gum Senegal, and other Foreign Gums.

Gum Senegal, or other foreign gums, have hitherto been indiſpenſably requiſite for fine goods, and thoſe of light ſhades of colour.

No proper ſubſtitute had been found to anſwer for this part of calico printing, until Lord Dundonald diſcovered the preparing gum from the lichen.

Gum Senegal, and foreign gums, are at times ſcarce, and difficult to be procured.

The ſettlement of Senagambia belongs to the French. They have a monopoly of gum Senegal. The price ſince the war has riſen from 150l. to 400l. per ton.

Gum from the lichen may, all charges included, be prepared at one-fourteenth part of the preſent price of gum Senegal, and at one-ſixth of the peace-time price.

The United Kingdoms may now be ſaid to be independent of foreign ſtates for the gum requiſite for their manufactures, ſuch as calico printing, preparation of ink, ſtaining and manufacture of paper, dreſſing and ſtiffening ſilks, &c. &c. And, in conſequence of Lord Dundonald's diſcovery, large ſums of money formerly ſent abroad for the purchaſe of gum, will, in future, be ſaved.

Starch and wheaten flour have hitherto been uſed as cheap ſubſtitutes for gum, in printing coarſe goods, or to fix on other printed goods, the mordants, and ſome of the dyeing materials, for deep ſhades of colour. But there is now reaſon to expect, as gum from the lichen will coſt leſs than thoſe articles, particularly *ſtarch*, it will be uſed in their ſtead, and ſo prove the means of ſaving, or œconomizing a conſiderable proportion of wheat and wheaten flour, at preſent conſumed in calico printing.

The collecting the lichen from the foreſt and fruit trees and hedges, will give employment to a number of poor people, principally women and children.

A cheap ſupply of gum from the lichen, may perhaps, in ſeveral manufactures, ſuperſede the uſe of the higher priced article of glue or ſize, which often has a very diſagreeable ſmell.

Gum from the lichen, may perhaps, be uſed as a dreſſing in weaving, particularly fine goods, either by itſelf, or when made into a kind of ſoap, according to directions given in a ſeparate publication.

Laſtly,

Laftly, It is probable that all the benefits to enfue from the difcovery of procuring gum from the lichen may not yet have occurred, it being well known, that there is no art or difcovery that is not the parent or fifter of fome other.

VI.

On the Nature of Galvanifm, Electricity, Heat, the Compofition of Water, and the Theory of Chemiftry. By a Correfpondent.

To Mr. NICHOLSON.

SIR,

THE more I confider the objections which I ftarted refpecting the explanation of the phenomena on the application of the influence from the pile of Volta to water by means of wires, the more am I convinced that the fyftem of chemiftry, according to M. Lavoifier, is not applicable to the appearances which are continually prefenting themfelves. However that fyftem may be fanctioned and fupported by the confent of eminent philofophers, yet I truft that in every difcuffion of fubjects of natural philofophy, the laudable defire of acquiring truth will outweigh any prefumption which may appear in an oppofition of fuch favoured doctrines.

The communication from Dr. Babington, which appeared in your late Journal (IV. 511), was decifive. It clearly proves, what I had ventured to fuggeft, that water is not compofed of the bafes of oxigen and hidrogen air. If the two gafes feparated from water by the pile were collected, and the hidrogen air burnt in the oxigen air, would not in that inftance the two kinds of electricity be converted into ordinary culinary fire? It appears that on burning thofe airs together, the water, when collected, has loft none of its weight; if fo, does not the fire produced originate from the pofitive and negative electricities? If water is not decompofed by the pile, whence comes the hidrogen? Hidrogen not being a component part of water, its name furely ought to be changed. If the original weight and quantity of water be again collected after the combuftion of thofe airs, which have been fuppofed to be its conftituent principles, by what procefs of reafoning can we affent to the bafes of thofe airs being peculiar elements or radicals. If the matter of heat were a fimple body, and if the gafeous ftate of thefe radicals depended on the greater capacity they have for caloric, whence comes the difference obferved between them when they are becoming fixed; and why does one kind of electricity invariably produce the fame air? The following is the manner in which the phenomena of the folid, liquid, and gafeous ftates of bodies are defcribed according to the theory of M. Lavoifier.

All bodies, from their combination with caloric, may exift in three different ftates, which refult from:

1. The

1. The power of attraction by which bodies cohere.

2. The quantity of caloric with which the ſubſtance is combined.

3. The greater or leſs preſſure of the atmoſphere.

The means by which a ſolid body may be converted into a liquid are therefore

1. A combination with a new and ſufficient quantity of caloric.

2. An union with another body already liquid.

A liquid is changed into the ſtate of gas

1. By being combined with a quantity of caloric ſufficient to equipoiſe the preſſure of the atmoſphere.

2. If the preſſure of the atmoſphere be either ſufficiently diminiſhed or totally removed.

According to this ſyſtem, therefore, there exiſts no difference between gaſeous bodies but from the difference of their reſpective baſes; the caloric is common to all. Why, therefore, does oxigen air, when united during combuſtion with charcoal, give out fire with flame, whilſt other gaſes, even when inſtantly changed into a ſolid, give out only heat? Or why is one portion of water from the pile wholly converted into oxigen gas? The minus ſide certainly cannot form a gas by abſtracting fire, even though it ſhould be in the ſtate of electricity.

It appears, therefore, that the theory of M. Lavoiſier is defective, in as far as it proves neither the decompoſition of water, nor the nature of permanently elaſtic fluids. I could bring forward many experiments in a new form to prove the fallacy of the ſyſtem of M. Lavoiſier, but we have already ſufficient facts before us to demonſtrate upon what a ſlight foundation it reſts.

The explanation of moſt of the phenomena of chemiſtry is involved in this diſcuſſion. The nature of the atmoſphere and of vapours, combuſtion and all the appearances of light, heat and electricity, chemical ſolution, decompoſition, &c. in ſhort, the whole ſyſtem of M. Lavoiſier totters, ſince we know that water is not compoſed of the baſes of oxigen and hidrogen air.

As I mean this only as a notice, I ſhall not inſiſt further at preſent on the ſubject. As I mean to purſue it ſyſtematically and by experiment, I hope I ſhall not intrude too much upon you by occaſionally ſubmitting to you the reſults of my inveſtigations.

I have the honour to be

Your obedient humble ſervant,

AN EXPERIMENTALIST.

March 7, 1801.

P.S. I find that heat is eaſily decompoſed, and that the Galvanic influence may be detached from a very great variety of ſubſtances.*

* I am ſorry to be under the neceſſity of apologizing to this Correſpondent for the late appearance of his letter, which was occaſioned by its having been placed by miſtake among ſome other papers of a different nature.- -N.

VII.

Notice respecting the new Method of Bleaching, and its Application to the Washing of Linen Garments. By Citizen Chaptal.*

TWENTY months ago I communicated to the Inftitute a procefs, no lefs fimple than economical, by means of which cotton goods could be bleached in a very fhort time.

This procefs was fpeedily rendered public by the journals, and the Englifh availed themfelves of it to fuch advantage, that, a fhort time afterwards, it was adopted and brought to perfection in the capital manufactory of linen which exifts in Ireland. †

The fuccefs of this procefs, in the hands of a rival nation, has awakened the exertions, and excited the intereft, of fome French manufacturers. Citizen Bawens, proprietor of a manufactory of cotton-yarn and piece-goods, at La Barriere des bons Hommes, applied to me for information refpecting this procefs. I gave him the dimenfions of the apparatus, and the conftruction was intrufted to Citizen Bourlier, a diftinguifhed chemift, and proprietor of the fal ammoniac work at Gros-Caillou. The firft experiment, which was made in the works of Bawens, was performed upon 2000 metres of cotton in the piece. The refult was fo advantageous in every refpect, that Citizens Bawens and Bourlier affociated together to form fimilar eftablifhments in various parts of the Republic. Citizen Bourlier is at this inftant in Belgia, where he has eftablifhed works of this kind to fuch an extent, as to be able to bleach a large proportion of the goods which are manufactured in that country.

I muft obferve that the procefs which I have defcribed has been fingularly improved by Citizen Bourlier. He has contrived eafy methods of turning the goods in the apparatus, and prefenting all their parts to the vapour. He has found that linen requires in fact only a weak ley; but that it is neceffary to alternate the action of the ley with that of the atmofpheric air, in order to bleach completely. He has fucceeded in giving a degree of whitenefs in two or three days to the coarfeft goods which the ufual procefs of the bleachery could not communicate but in a much longer time, and with more expence.

I have the honour to prefent to the clafs famples of dimities and cloths bleached by Citizen Bourlier. It will be feen that the colour is equal to any thing which has hitherto appeared in the market.

I fhall not enlarge more fully on the advantages which commerce muft derive from this method, but fhall confine myfelf to obferve that the firft experiments, which are always the moft expenfive, did not carry the price of bleaching to more than half the ordinary price.

* Annales de Chimie, XXXVIII. 291.

† The details of this method may be feen in a work of Citizen D'Orelly, entitled, "Effai fur le Blanchiment;" fold by Deterville, Rue du Battoir, No. 6, at Paris.

I have no doubt but that linen garments may be bleached to advantage bythe ſame proceſs; but as it was neceſſary to bring theſe notions to the teſt of experiment, I invited Citizen Bawens to allow me to make the experiment on a large ſcale with his apparatus. Accordingly, on the 27th Pluvoiſe, in the year IX. I had 200 pair of ſheets from the hoſpital of the *Hotel Dieu* at Paris, choſen among thoſe that were moſt ſoiled, and taken to the manufactory of Citizen Bawens.

Three experiments were made upon theſe ſheets.

Experiment 1. One hundred and thirty ſheets were impregnated with a cauſtic alkaline ley, containing one hundredth part of ſoda. They were kept for ſix hours in the engine of ſteam; after which they were impregnated again, in order to be placed again ſix hours in the ſame machine.

The ſame proceſs was repeated a third time; after which they were carefully rinſed, and no ſpot of wine, greaſe, blood, or animal ejection, was to be ſeen. One quarter of a pound of ſoap was uſed in rinſing theſe cloths.

All the aſſiſtants were convinced that the ordinary proceſſes would not have given either ſo perfect a white, nor ſo agreeable a lixivial ſmell.

The texture was in no reſpect altered.

Experiment 2. The alkaline ley contained only ſix parts of ſoda, but five pounds of ſoap were alſo added. The cloths were treated in the ſame manner, and the reſults appeared more advantageous. They were more eaſily waſhed out.

Experiment 3. To the bath of the ſecond experiment a ſufficient quantity of new ley was added. One hundred and forty ſheets were treated like the preceding, and the reſult was the ſame.

It muſt be obſerved that the water of the Seine, in which theſe ſheets were rinſed, was at that time very yellow.

This experiment appeared to me to offer ſeveral reſults worthy the attention of the Inſtitute.

In the firſt place the proceſs is economical. Two hundred pair of ſheets, which were bleached by three ſucceſſive operations, demanded an expenditure, according to the account furniſhed by Citizen Bawens, which is in the proportion of 7 to 10, compared with that commonly made in the hoſpitals. This expence may be reduced to leſs than one-third, if a ſuitable place and apparatus were appropriated to this uſe.

2. Two days at moſt are required to complete the operation. This œconomy of time is incalculably beneficial.

3. The linen is neither changed nor torn, as it paſſes through the hands only once, and it is of no uſe to beat it.

4. The extreme heat to which the linen is expoſed in the apparatus, cauſes its texture to be penetrated by the alkaline fluid to ſuch a degree, that the ſubſtances with which it is impregnated cannot be maſked from its action; ſo that the putrid exhalations, and other ſubſtances attached to its texture, are neceſſarily deſtroyed or changed in their nature.

This

This effect must be more particularly seen with regard to its value, by physicians, who are aware with what facility the seeds of various disorders are perpetuated in hospitals, and how insufficient the greater number of processes used in washing linen have proved to destroy them.

SCIENTIFIC NEWS, ACCOUNTS OF BOOKS, &c.

Notice relative to the Gadolinite. By CIT. HAUY.

THIS substance was discovered at Ytterby, in Sweden. In the year 1794, M. Gadolin announced the existence of a new earth; and his assertion has since been confirmed by M. Ekeberg's analysis of that substance, to which he has given the name of Gadolinite, in honour of the discoverer, and he has denominated the new earth Yttria, a name derived from the country where the mineral that contains it was discovered.

From the description published in the Journal de Physique for Fructidor, 8th year, it appears that the Gadolinite has a tolerably perfect black colour; it breaks in an imperfect conchoid form; it is brilliant, and its polish is vitreous; its specific gravity is also considerable.

To these external characters may be added others of a physical and chemical nature, already in part known, by which the Gadolinite is clearly distinguished from some other minerals to which it resembles in its aspect, particularly the vitreous lava denominated lapis obsidianus. Its specific gravity, which Cit. Hauy has found to be 4,0497, is greater than that of the above-mentioned lava, nearly in the proportion of 5 to 3; but it is less than that of black sulphurated uranium, called pech-blende, in the proportion of 2 to 3. The Gadolinite likewise, when reduced to powder and put into nitric acid, diluted with water, is discoloured on heating the acid, and converted into a kind of thick jelly, of a yellowish grey colour. According to the observations of Cit. Lelievre, the Gadolinite, when exposed to the flame of the blow-pipe, decrepitates, and emits particles apparently inflamed: but if care has been taken to ignite it by the flame of a candle, it does not decrepitate: it acquires a red tinge, intermixed with white; cracks, and does not melt, unless the fragment be very small. The Gadolinite acts very sensibly upon the magnetic needle, but Cit. Hauy has not discovered that it has poles.

M. Ekeberg obtained from the Gadolinite 47.5 parts of Yttria, 25 of silex, 18 of iron, and 4,5 of alumine: the loss was 5. Cit. Vauquelin, on repeating this analysis, found 35 parts of Yttria, 25,5 of silex, 25 of iron, 2 of oxide of manganese, 2 of lime, with a loss of 10,5, the cause of which he investigated, and attributes it principally to the water contained in the Gadolinite, and to a small quantity of carbonic acid. He observed that the new earth has some analogy to glucine. Like that substance it forms saccharine solutions

with acids, but their tafte is rather more acrid, and more nearly refembles that of folutions of lead. The Yttria likewife differs from glucine, becaufe it is not foluble (like the latter) in cauftic alkalies; and becaufe the falt which it forms with the fulphuric acid, inftead of being foluble, as it is when glucine conftitutes the bafe, is on the contrary fcarcely at all foluble; and, laftly, becaufe it is precipitated from its folutions in the acids by the pruffiate of pot-afh, which does not take place with glucine.

The pieces of Gadolinite treated by Citizens Vauquelin and Hauy, for the purpofe of afcertaining the nature and characters of that fubftance, were prefented to them by Meffrs. Abildgaard, Manthey, and Neergaard.

Soc. Philom. No. 44, An. 9.

Note relative to the new Earth denominated Yttria. By M. KLAPROTH.

THIS earth, which contains Gadolinite, not only poffeffes the common property of glucine, of forming falts of a fweet tafte, but it alfo readily diffolves in a folution of carbonate of ammonia. It neverthelefs has peculiar characters, which, diftinguifhing it from the earths, renders it in fome degree fimilar to the metallic oxides. With the fulphuric and acetic acids, it forms cryftallized falts, of a pale rofe colour: it is precipitated from its combinations by tannin and by Pruffian alkali.

The proportion of Yttria in the Gadolinite, ftated by Ekeberg, is not very exact. The caufe of this may probably be attributed to the method he employed to feparate the Yttria from ferruginous fubftances, which induced him erroneoufly to imagine that the fulphate of Yttria is not decompofed by fire. This decompofition, however, does take place, but not fo readily as that of the fulphate of iron. M. Klaproth has afcertained by his analyfes that Gadolinite is compofed of 21,15. parts of filex, 18. of oxide of iron, 59,75. of Yttria, and 0.50. of alumine. This fmall quantity of aluminous earth is probably merely accidental, and perhaps proceeds from fome particles of feld-fpath accompanying the Gadolinite.

Note on fluated Alumine and Phofphate of Copper.

M. KLAPROTH has completed the analyfes of the fluated alumine, named *Chryolite of Greenland.* It confifted of $23\frac{1}{2}$ parts of alumine, 36 of foda, and $40\frac{1}{2}$ of fluoric acid and water of cryftallization. He confiders the difcovery of foda in ftony foffils as particularly remarkable. It is at leaft the firft inftance of fo great a quantity of this alkali being found in a ftone, or rather in an infoluble falt.

Cit. Vauquelin has repeated the analyfes of fluated alumine. The refult was, alumine 21, foda 32, fluoric acid and water of cryftallization 47. This chemift obferves, that in the

the alumine were discovered five parts of a substance having an earthy appearance, but which does not form alum, and is apparently insoluble in the acids. He conceives this substance may be silex.

M. Klaproth has also discovered a native phosphate of copper, and is at present employed in analysing this new combination of the phosphoric acid.

*** *The two last Articles were communicated by Letter from Klaproth to Vauquelin, Bulletin des Sciences, No. 45, Frimaire,* IX.

On a new Manner of preparing the Acetic Acid. By CIT. BADOLLIER, *Apothecary at Chartres.*

THE process of Cit. Badollier consists in distilling a mixture of equal parts of sulphate of copper and acetite of lead, on the sand bath, in a glass retort adapted to a receiver.

To examine the produce, Cit. Badollier made use of the pneumato-chemical apparatus. During the operation, he obtained only a small quantity of elastic fluid, which he found to have proceeded from the dilated air contained in the vessels. This air, tried by the usual tests, afforded no indication of carbonic acid. As he presumed that his acetic acid might contain a portion of sulphuric acid, he tried it by a solution of the muriate of barytes, which did not cause any precipitate.

It must be observed, that the distillation is speedily made, and requires a very moderate heat; and the acid thus obtained possessed no empyreumatic smell; that the quantity, as well as quality, were equal to those obtained by the distillation of the acetite of copper; and that there was not, as in the old process, a portion of decomposed acid, communicating a disagreeable smell to the whole product. On account of the time and fuel saved, the price of the acid prepared by this new process, is to that obtained by the distillation of the acetite of copper, as 1 to 4.

Annales de Chimie, XXXVII. 111.

On the Phosphorescent Properties of the Medullary Substance of the Brain and Nerves, extracted from a Memoir of CIT. CABARRIS, *read before the National Institute.*

IT is well known that phosphorus is derived from animal matter. It is also indeed found in the mineral kingdom; but it may be questioned whether its origin, like that of calcareous earths, may not always be referred to animal recrements; that at least which is the direct product of these recrements, may be considered as the immediate effect of

sensitive

fenfitive life, as a refult of the changes which the animal folids and fluids are fufceptible of undergoing, or as one of the fimple fubftances which they poffefs the peculiar property of affimilating. In the bodies of animals which are undergoing decompofition, phofphorus appears to enter into a flow combuftion. Without producing real flame, without at leaft the power of igniting combuftible bodies in its immediate vicinity, it becomes luminous, and throws out flafhes of light amid the furrounding darknefs, fufficiently vivid to afford fome real foundation for the exiftence of thofe phantoms, which people are at once defirous, and afraid of feeing, in the neighbourhood of cemeteries. The brain and its appendices, or rather the nervous fyftem in general, appears to be the peculiar refervoir of phofphorus; for it is the incipient decompofition of the cerebral pulp which gives rife to thofe phofphorefcent lights which, during the darknefs of the night, are frequently obferved in anatomical theatres; and it is chiefly around the brain expofed by being deprived of the natural coverings, or the fragments of nervous matter lying on the tables, that they are perceived. A variety of obfervations have led me to conclude that the quantity of phofphorefcent matter developed after death, bears fome proportion to the activity of the nervous fyftem during life. I think I have noticed that the brains of perfons who have died of difeafes marked by a ftrong augmentation of this activity, gave a greater, as well as a more vivid light. Thofe of maniacs are peculiarly luminous; thofe of dropfical and leucophlegmatic fubjects much lefs fo.

Combuftion of Metals by Galvanifm.

PROFESSOR Tromfdorf prefented to the Electoral Society of ufeful Literature at Erfurth, April 8th, a Volta's pile, and exhibited in the prefence of the Prince Bifhop de Conftanz, fome experiments, part before known, and part new.

The pile of Profeffor Tromfdorf was built up of 180 pair of plates, of zinc, copper, and wetted paper.

The fhock which this pile was capable of giving was very ftrong, and the fpark confiderable.

Profeffor Tromfdorf, after having fhewn the production of hidrogen, and oxigen gas, the oxidation and de-oxidation of metals, &c. exhibited the combuftion of metals, both perfect and imperfect; a fact hitherto unknown to us.

A leaf of fine gold, after having been affixed to the zinc fide of the pile, took fire, and burnt with a crackling noife, when the wire of the copper fide was brought in contact with it.

A leaf of fine filver took fire in a fimilar manner, and burnt with a green flame; brafs burnt reddifh brown; laminated copper, emerald-green; zinc, whitifh-blue; tin, reddifh-white, &c.

 In

In order to infure fuccefs in the exhibition of thefe experiments, Profeffor Tromfdorf remarks, that the metals fhould be rolled out very thin, though he does not doubt that a larger pile would be capable of inflaming larger maffes.

To prove that the accenfion of the perfect metals is a true oxidation, the experiments may be performed in a hollow glafs fphere; the oxide will then adhere to the fides of the glafs, and may be collected.

Profeffor Tromfdorf is now engaged in the conftruction of a larger pile, confifting of 5 or 600 pairs of plates.

Algemeine Literatur Zeitung LXXXIV. *July* 16, 1801.

THE combuftion of metals by galvanifm has alfo been effected in a fomewhat different way by Fourcroy in France. An account of this experiment was given in the Moniteur about two months ago; but as the fet to which I have accefs appears to be defective for want, as it fhould appear, of this very Paper, I muft, for the prefent, give the particulars from recollection. A pile of plates of zinc and filver fix inches, or more in diameter, and confifting of no more than fix plates of each metal, was conftructed in the ufual manner. It gave little or no perceptible fhock, but the galvanic ftream, when paffed through fine wire, ignited and difperfed it. The moft remarkable fact in this exhibition is, that the fame furface formed into a pile with more reiterations; as for example, when the plates were cut into four, and conftituted twenty-four repetitions, gave ftrong fhocks, but did not exhibit the combuftion of wire. From this curious incident we derive a law of galvanifm before unknown, which is not only in itfelf very ftriking, but will tend to improve our knowledge of the electric fhock, if electricity be the fame as galvanifm, or to mark their differences more effectually, if the contrary pofition fhould hereafter be rendered probable.

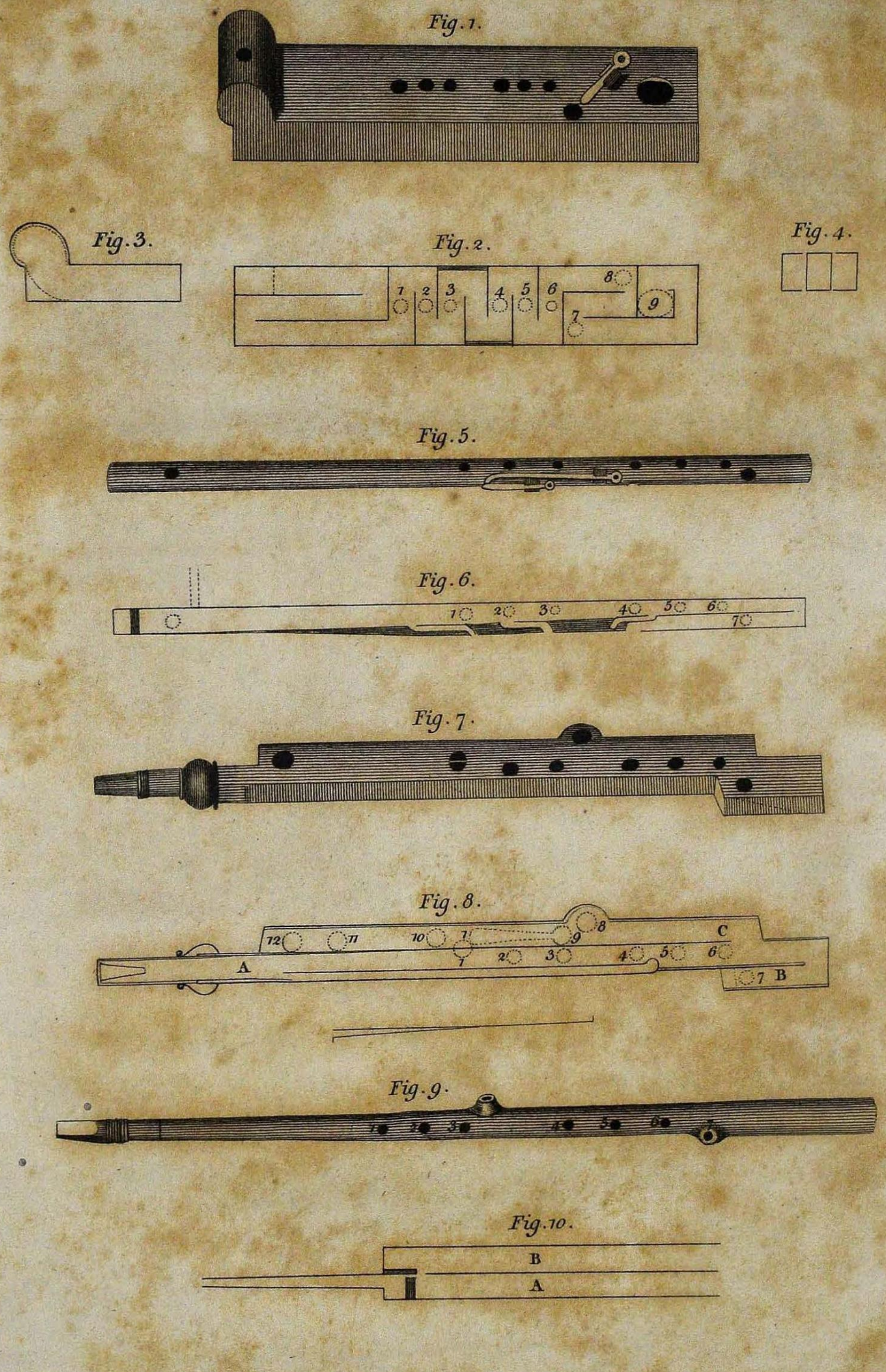
Galvanic luminous Signs of the two Electric Powers.

MR. Cruickfhank of Woolwich, has favoured me with an account in converfation, of the flafh of light attended with noife, which he obferved many months ago, and mentioned to me formerly in a letter, from which an extract is given at page 80 of the prefent volume. The apparatus made ufe of to produce the galvanic current is there defcribed, namely, two troughs, confifting each of 120 pair of plates of zinc and filver, foldered together all round the edge. If the communication be made from one end of this fyftem to the other, by means of a wire having one of its extremities plunged in the fluid, fo as to communicate with the zinc face, and the other extremity of the wire be applied to the fluid at the end to which

which the furfaces of the filver plates are oppofed, a flafh or brufh of light, vifible in clear fun fhine, is feen upon the furface of the water at the moment of contact or immerfion; attended with a noife exactly fimilar to that of plunging a red hot wire in water, and accompanied with an ebullition of the fame kind, as is produced by fuch an immerfion. The length of the brufh is about half an inch, and the noife may be heard acrofs a room. On the contrary, if the permanent connection, or immerfed end of the wire be at the filver end, or that extremity which would feparate hidrogen from water, and the application or contact be made to the fluid at the zinc or oxigen end, nothing is feen but a fmall globular fpeck of light, fcarcely vifible unlefs the machine be very powerful at the fame time that there is very little effervefcence, and no noife at all.

From my experiments at page 184 of the 4th Volume of this Journal, which have fince been repeated and varied by numberlefs operators, it is determined that the zinc or oxigen fide imparts the plus ftate of electricity, and the other fide the minus. The point of the wire was therefore plus when it gave out the luminous brufh, and minus when the fluid was filently conducted. This property of the two electricities was long ago fhewn by Franklin, and from fome new facts refpecting the operation of low points, was applied by myfelf to the conftruction of an inftrument called the Diftinguifher of Electricity, of which a drawing was publifhed in my Introduction to Natural Philofophy about fourteen years ago. The courfe of electricity from a battery, that is to fay, of a large quantity at a low or moderate intenfity, along the furface of fluids or moift fubftances, was the object of a feries of experiments many years ago by Dr. Prieftley, which he has publifhed in his Hiftory of Electricity. Dr. Wollafton has communicated fome very effective experiments to the Royal Society, by which the identity of the electrical and galvanic powers appears to be placed beyond controverfy, an account of which will foon be laid before the reader.

Mr. Close's Improvements in Wind Instruments.



Mutlow Sc. Russell Court.

Mr. Walker's freezing Process.

Fig. 1.

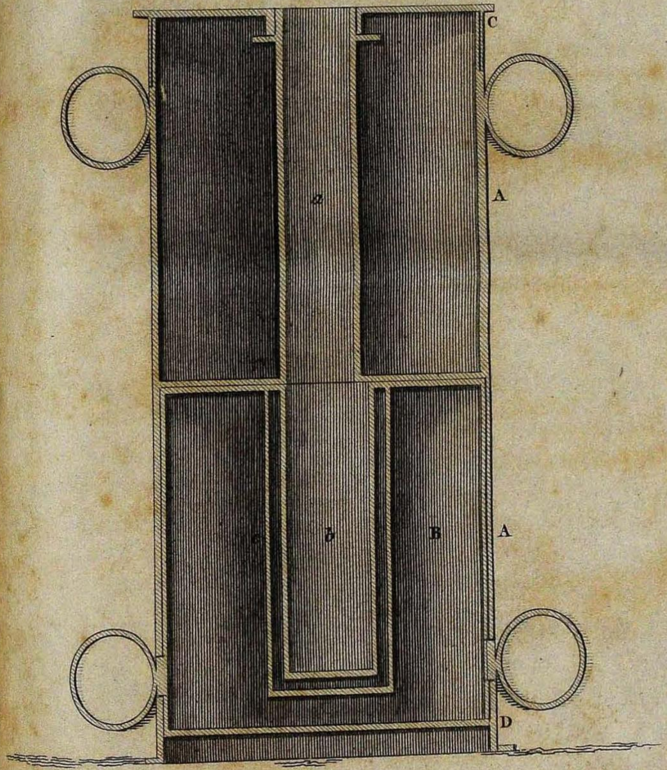
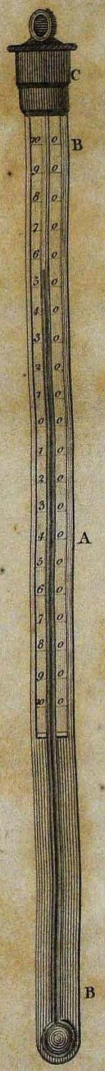
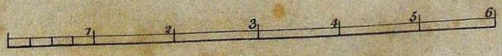


Fig. 2.





Scale of Inches.

Mutlow Sc. Russell Court.